PART II.

Municipal Architecture in Boston.

From Designs by Edmund M. Wheelwright,
City Architect,
1891 to 1895.

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PART II.

MUNICIPAL ARCHITECTURE IN BOSTON

From Designs by EDMUND M. WHEELWRIGHT
City Architect, 1891 to 1895

Edited by FRANCIS W. CHANDLER
Professor of Architecture, Massachusetts Institute of Technology
Fellow of the American Institute of Architects

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Part II

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EDMUND M. WHEELWRIGHT

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PART TWO.

HOSPITAL, INSTITUTIONAL, AND MISCELLANEOUS BUILDINGS.

I.

The Evolution of Hospital Construction exemplified in the hospitals of Boston.

THE hospitals that have served their purposes for the City of Boston, from the earliest ones to the culmination of their excellence in the Boston City Hospital as it stands today, exemplify the development of the principles of hospital construction. This natural process of evolution has a special interest here; these hospitals, as they were built from time to time, were well suited to the work for which they were designed in accordance with the best understanding which experience had then taught of their requirements. There were never any serious errors of construction, according to the present conception of what is within the limits of serviceable forms; no massive and costly block hospital, too many stories in height, has been built here for architectural effects in defiance of the fundamental requirements of light and air-space as essential among the remedial influences of a hospital.

Effect of wars between 1850 and 1875 on hospital construction.

The experience of the civilized world in the great wars of the third quarter of this century produced a remarkable change in the methods of caring for the sick and wounded. Prior to that time the prevailing ideas in regard to permanent hospitals were that they should be large buildings, in which their projectors could take pride as monuments of their philanthropic zeal, and as architectural adornments of the cities where they were built. They were of brick or stone, and in their forms there still appeared the influence of the monastic period, when, in the middle ages and later, hospitals were edifices under the control of religious bodies. The old Hôtel Dieu in Paris and the St. Thomas Hospital in London, with their crowded wards and terrible mortality, and many still existing hospitals in England and on the continent are examples of badly constructed hospitals. But during the Crimean War the superiority of tents and barracks over permanent hospitals of better construction was demonstrated. At the beginning of the War of the Rebellion, as had been the custom in emergencies in all previous wars of modern history, public buildings, schoolhouses, churches, hotels, factories, and the like were used as hospitals. But gradually one-story wooden pavilions erected for the purpose or portable hospital tents came into general use. The results gained in these hospitals seemed to establish the principle that all constructions for hospital purposes should be temporary, and so cheaply built as to make it practicable to destroy them and build anew every twelve or fifteen years. Interesting examples of one-story square wards of modern construction may be seen at the Massachusetts General Hospital. They were built twenty-five

years ago, but after twelve years were so little impaired that permanent foundations were put under them, and they promise to do good service for many years longer. Two similar pavilion wards were built at the Boston City Hospital in 1876. The best opinion in hospital construction so far prevailed that between 1854 and 1875 many hospital buildings of this character were erected in this and other countries. The substantial, permanent hospitals were regarded with regret for their cost, as only to be tolerated, and as requiring great care to correct their evils. It was believed that the high rates of mortality in such hospitals was due to defects of construction; and that, as the well are made sick by "crowd-poisoning," so the sick, placed under like influences, are all the more surely hurried to their death. The names "hospitalism" and "hospital influence" were given to these evil conditions, and certain hospital diseases were recognized as having their origin in the hospital. It was this that led Florence Nightingale to say, "It may seem a strange principle to enunciate as the first requirement of a hospital, that it shall do the sick no harm."

Hospitalism.

Principles deduced from the experience of these wars.

The experiences of the great wars had proved that the safety of the sick and wounded against the infectious influences of hospitalism could be secured by separating the patients from each other, by giving them ample air-space in one-story buildings and a sufficient supply of pure air, and by maintaining cleanliness. It was found that even "a bad hospital could be made a good one by good keeping." The events above described were coincident also with the establishment of the great reform in nursing, which is a contribution of inestimable value to modern advancement in the care of the sick.

Effect of the germ-theory on hospital construction.

The germ-theory of disease, when it became generally accepted, had the effects above described upon the construction of hospitals. In this theory was found an explanation of the evils of aggregating patients in hospital wards, with the difficulties of ventilating and supplying pure air, especially when the wards were placed one over another in high buildings. The first efforts were, as it has been shown, to protect the sick by the mechanical means of separating them more from each other and by promoting cleanliness. Then came, with the better knowledge of the causes of disease, the further advancement of medical science which constitutes the great revolution in the principles and practice of medicine that the present generation is witnessing. With the safeguards of asepsis in hospital methods, the term "hospitalism" became obsolete; it is the principle of cleanliness, in the absolute prevention, exclusion, or destruction of septic germs. Extreme measures in the modifications of construction are no longer required. Almost any hospital ward can now be kept free from infectious influences; and, in the older existing hospitals, by giving each patient sufficient floor-space, air-space, and air-supply, wholesome conditions can be maintained for the majority of inmates who are suffering from ordinary diseases not of an especially infectious or contagious character. Thus hospital buildings of a more durable and comfortable character, with perfected devices and equipments for their work, became not only proper but better in all respects than the temporary constructions in which certain defects were inevitable.

Hospitals are now constructed according to scientific principles.

The science of hospital construction then assumed a more definite form. Under the new conception of its requirements, the first notable example of the perfection to which a permanent modern hospital may be brought is to be seen in the Johns Hopkins Hospital in Baltimore, the building of which began more than twenty years ago. The principles of construction thus exemplified are now generally accepted with modifications and adaptations to the various requirements of large and small hospitals, according to their general or special characters and the circumstances of their location. The soundness and truth of these principles are manifest in the continued evolution of improved forms as the special requirements become better understood in different cases.

The general principles that should govern the building of hospitals demand first that they should serve the best interests of the sick. This simple statement involves conflicting indications. The sick person is under the best conditions for treatment, other things being equal, who is in a house by himself, separated from all others who are sick; but proper economy in the humane care of many who need it demands that they shall be aggregated in considerable numbers. Moreover, with the modern advancement in methods of treatment, the complexity of manipulation in the art of medicine requires special conditions for its practice. Thus hospitals are becoming more and more necessary for the rich and poor alike, because so many things can be done only in them, or can be done in them so much better than in private homes. The problem of hospital construction, then, becomes one of accommodating the conflicting indications to suit different circumstances. Thus certain principles of construction have come to be accepted as axioms.

Certain principles axiomatic.

The unit of construction is the hospital ward. The size of the ward may vary for small or large hospitals and for different classes of patients; but a permanent hospital ward should never be larger than to contain from twenty to thirty-two beds. The latter number is only allowable for patients of the chronic class, as in infirmaries. This is accepted as the limit of safety in the aggregation of patients in a single room; and it suits the indications of economy as to convenience of administration and cost of service; for a single nurse cannot at any time oversee a larger number of patients. In smaller hospitals, or in wards for special cases, there may be sometimes as few as from four to ten beds, while some single rooms are necessary. For the proper separation of patients it is further required that these ward units of construction should be properly placed. In general, each of the larger wards should be in a separate building forming a pavilion of one story, especially if occupied by patients with acute infectious diseases, or by serious surgical cases. Exceptionally such pavilions may be two-storied, and still more rarely, in large hospitals, they may contain a third story. This is permissible because in such hospitals there may be a proper classification of cases to suit the circumstances. The pavilion was formerly considered to be best when forming a long ward with opposite windows and rows of beds; but wards that are square, octagon, or circular in shape, with fire-places and a chimney and vent-shaft in the centre of the ward, are found to be satisfactory. The important points in regard to these forms of wards include, besides convenience of service and the movement of air currents within the wards, the greatest possible exposure of the exterior walls of the room or building to the sunlight, and the placing of windows at proper intervals around the whole circumference of the ward, or as nearly so as is practicable. In oblong wards these conditions can be provided on their long sides and usually at one end, where a "sun-room" is commonly placed. In an octagon or circular ward, the entrance through a comparatively narrow corridor connection permits an arrangement by which nearly the whole exterior wall of the pavilion is exposed to light and air. The requirements as to floor-space, air-space, etc., are more properly subjects for discussion in another section, relating to the warming and ventilating of hospitals. The grouping of the pavilions, their distance apart, their association with receiving, examining, and operating rooms and their accessories, and with the administration and service departments, are subject to questions of location, exposure to sunlight, convenience of supervision, etc., in each case. It is intended here not to make a complete statement of the requirements in detail; but only to indicate the nature and complexity of the problem, and to present a general view of its elements to which further reference will be made.

The ward the unit of construction.

At the beginning of this discussion of the evolution of hospital construction it was stated, in regard to the hospitals which have served their purposes for the city of Boston, that their

The Massachusetts General Hospital.

history shows no material errors of conception or of form of construction. In the light of modern ideas indicated in the foregoing brief review, the older wards of the Massachusetts General Hospital, instead of being considered quite unsuitable as they were twenty-five years ago, are now satisfactory and are to be regarded as excellent for the classes of patients for which they are used. This hospital, opened in 1821, is a block hospital of granite, with a central part of three stories, above which is the old surgical amphitheatre; the two wings have two stories of wards above the basement on the ground level, which is used for business purposes. In each story of each wing there are two square wards of twenty beds each, the arrangement being such that four of the eight wards have windows on three sides, and the other four have opposite windows. With their central ventilating shaft, etc., they formed the model for the one-story wooden square ward, before referred to, built in 1872. The more serious and acute cases being further provided for by one-story structures of permanent brick construction, the old wards are left to do the work for which they are suited; and their usefulness will continue indefinitely. To modernize them it was necessary only to remove the toilet and other service rooms to exterior towers. The new square wards just mentioned, and the other new oblong buildings, with two rows of opposite single rooms on either side of a corridor extending into a high monitor roof above the main roof, have in their turn formed the models for many hospital wards. Their influence is seen in the construction of some of the wards of the Johns Hopkins Hospital.

Earlier Hospitals.

The Massachusetts General Hospital, dating from 1821, was the third of its kind in this country. It followed the old but still useful Pennsylvania Hospital in Philadelphia with its capacity recently doubled by modern wards, a surgical building and nurses' home, and the New York Hospital, which was replaced some years ago by a higher and more complicated structure. But the Massachusetts is still a good hospital according to the latest dicta. The earlier hospitals were temporary in character. After the establishment of a quarantine in Boston Harbor in 1647, its first hospital was built on one of the islands in 1717. Later there were pest-houses at the principal seaports, and secluded houses in the country were used as such in the epidemics of small-pox, the first hospital for inoculating and treating the disease being established in Boston in 1764 in military barracks or similar buildings. For some time, buildings of simple construction were provided for cases of this disease, until, some years ago, the present permanent hospital was built by the city for this purpose. While the early hospitals were suitable for their uses, there was none for general diseases in the Commonwealth at the beginning of the century, except that the first United States Marine Hospital was built in Charlestown in 1803.

The Boston City Hospital.

The Boston City Hospital was the first notable institution of its kind to be erected in Boston after the Massachusetts General Hospital. The City Hospital was completed in 1864. It was the result of concerted efforts on the part of the medical profession in Boston, whose views as to the constructional requirements of a hospital were so far regarded that the two pavilions containing the wards, as originally designed, were only two stories high. The merit of these pavilions was somewhat impaired, during the first years of their use when there were no other accommodations in the hospital, by the placing of a ward in a third story partly constructed in the roof, with the result of overcrowding the buildings with acute cases. But with the subsequent great extension of the hospital, these first pavilions now fittingly serve their purpose. The Administration Building presents an ornate appearance with its handsome dome, like that of St. Peter's, and its corridors curving forward to the right and left to the two pavilions above described. This building, which was at first quite out of proportion to those which surrounded it, has since become an appropriate centre for such a group of municipal hospital buildings as is nowhere excelled.

An especial interest attaches to the Boston City Hospital, because it was the first in America for which the separated pavilion plan was adopted, except that the Philadelphia Episcopal Hospital completed a single pavilion in 1862. The first pavilion hospital of importance was built only about ten years earlier in Paris. Soon after the opening of the City Hospital an isolating pavilion of two stories was added. With a normal capacity of two hundred beds, the hospital became so overcrowded in the course of the next ten years, that extensive additions were made by two buildings placed as wings to the central one but detached from it, and by two wooden pavilions of one story each for fever patients and acute surgical cases. The two buildings first mentioned were, like the pavilion built in 1862, of three stories; but they contained small wards, private rooms, operating rooms, a surgical amphitheatre, receiving rooms, offices, etc. This enlargement of the hospital, made during its administration by the writer of this section, was completed in 1876. It should be noted that these additions were wholly guided by medical opinion, through consultations with the members of the professional staff of the hospital.

Enlargement of the Boston City Hospital in 1876.

Since the War of the Rebellion, now more than thirty years ago, many important hospitals have been built throughout the country, adopting in most cases, more or less completely, the pavilion plan. In Boston the chief examples of these are The New England Hospital for Women and Children, The Children's Hospital, The Free Hospital for Women, and the Carney Hospital; the latter, however, is constructed on the block plan. Since the Johns Hopkins Hospital was completed twenty years ago, fine examples of hospitals including a number of pavilions, and the accessories of surgical buildings, pathological laboratories, nurses' homes, etc., have been built in many of the larger cities of the country. It is especially noteworthy that a large number of small hospitals have already been provided for many of the larger towns, particularly in Eastern Massachusetts; and they are becoming common in other States. During this period of the last twenty years, the theory of cheap constructions to be destroyed and renewed every twelve or fifteen years has had no influence. Nearly all the hospitals, large and small, have been substantial, permanent structures, usually of brick or of brick and stone. The smaller cottage and village hospitals are sometimes built of wood. The tendency everywhere in cities, except in a few examples of costly construction, is to keep to the axioms and principles that demand simplicity of form and the suitable distribution of the sick in small rather than in large buildings.

Other Hospitals.

A very remarkable effect has been produced during the last ten years upon the forms of construction for surgical work, operating rooms, and rooms for the first treatment of patients who have been subjected to operations. Here is seen the direct influence of the advancement in aseptic methods, and of the efforts to secure the absolute exclusion of infection. The first notable building of this kind was devised at the Massachusetts General Hospital in 1888, for "abdominal surgery." It consists of a one-story pavilion with monitor roof as before described, for fifteen patients in well-isolated rooms. The special feature of this building is the small, semi-detached, operating theatre with its interior finish of metal, marble and glass, and furnishings of like materials. In 1891, at the Johns Hopkins Hospital, a similar building was erected exclusively for the operative work of the gynecological department. Subsequently a more elaborate, separate pavilion for general surgery was built at the Presbyterian Hospital in New York containing the main theatre and minor operating rooms, with others for the etherizing and recovery of patients, and for sterilizing, keeping instruments, dressings, etc. Later was completed the most remarkable structure of its kind then in existence, the William J. Syms operating theatre at the Roosevelt Hospital in New York. It is a memorial hospital for which there was a bequest of $350,000. The effects of completeness and perfection are

Modern Operating Rooms.

given it by its large theatre and numerous smaller operating rooms with abundant sky light, the accessory rooms for all purposes, the finish of mosaic tiling in the floors, walls of marble slabs, and fixtures of metal, porcelain, and glass. A part of this building is three stories high and contains a number of rooms for patients under surgical treatment. The convenience of such an arrangement, in combining these purposes in one building contrary to ideas previously held, was believed to overbalance the dangers liable to arise from complexity of construction, difficulties of furnishing pure air, ventilating, etc. The results of this experiment appear to have demonstrated still further the effectiveness of aseptic methods in giving immunity from infectious influences under conditions that have been regarded as bad hospital construction. Thus we see another change in this evolution of ideas in this matter, and it is a change in the direction of a practical application of the governing principles. The effects of such an example quickly appeared; among the most recent and notable constructions of this kind being the new surgical building of the Pennsylvania Hospital, and of the Medico-Chirurgical Hospital in Philadelphia.

Enlargement of the Boston City Hospital in 1891-1895.

The Boston City Hospital, while the events mentioned in the preceding paragraph were happening, was rapidly outgrowing its enlargement of 1876. The surgical building with its operating theatre and accident room, etc., with wood floors and benches, and with the surgical out-patient department in the basement, had also a few private rooms and a ward for children in its upper stories. This building becoming inadequate, the work of reconstructing it was an important part of what was done by Mr. Wheelwright at the City Hospital between 1891 and 1895. The objects were to increase largely the space and the number of rooms for all branches of surgical operative work, to give them practical perfection according to the best modern ideas, and to overcome the limitations imposed by previous construction of this and the contiguous buildings. An examination of the plans of the three stories and basement of this building with its description in the following section of this volume will give an idea of the success with which the task was accomplished. The result befits the superior character of this great municipal institution, and marks an important stage in the evolution of hospital construction in respect to surgery. But there remained much more architectural work to be done, requiring originality of conception and execution, and these were shown in the new pathological building and the hospital for contagious diseases. These buildings being described in detail elsewhere, only a reference to their significant features is needed here.

The Pathological Building.

The Pathological Building, which constitutes a modern hospital laboratory, for which an ample appropriation was granted by the City to provide all its requirements as they were conceived by those who had professional charge of this department, was successfully planned and constructed. But with this utilitarian building was combined the novel problem of a Mortuary, and a Mortuary Chapel that demanded some architectural fitness for its purpose. The cut of this building shows how this was accomplished, introducing the device of a cloister, which has the most practical uses.

The South Department.

The Hospital for Contagious Diseases, called the South Department, is a complete hospital in itself, accommodating one hundred and eighty beds which may be increased to two hundred and twenty-four. In respect to the two pavilions for patients, the limitations of space demanded a radical departure from the approved practice. But the requirements for the classification and separation into small groups, and the practical isolation of those groups was accomplished in an entirely original manner. This meant the provision of isolated receiving or probation rooms, and isolated groups of rooms for separating different diseases and different stages of disease. Instead of procuring this separation by distributing the patients in small detached buildings, it was gained by the expedient of dividing each of the two stories of a

pavilion into four parts by open air passages on each floor crossing the building from side to side, and extending from basement to roof. The thoroughness with which all the details of rooms and wards, of heating and ventilating, and sanitary arrangements were worked out gives the practical effects heretofore gained by separated cottage wards.

An appreciative study of all this work of Mr. Wheelwright's, together with the fitly arranged accessories that cannot be mentioned here, shows that it is informed throughout by expert knowledge of hospital requirements. The successful issue combines the work of the skilled architect, Mr. Wheelwright, and the accomplished hospital administrator, Dr. Rowe, and testifies, in all its parts, to the harmony and sympathy with which they worked together, each an expert in his own line. In this particular, as in the more material ones, these noteworthy structures have achieved especial significance and distinction. In the history of hospital construction this recent work proves that its evolution is on the truest lines when the combination of ability, knowledge, and experience on all sides of the complex problem lead to such logical results. These buildings, together with the earlier work, constitute for the City of Boston a municipal hospital which is the most complete in all its appointments of any now in existence.

II.

Buildings for the Boston City Hospital.

THE buildings designed by Mr. Wheelwright for the Boston City Hospital consist of the group of buildings known as the South Department, and a number of buildings which form a part of the hospital proper. The South Department is a distinct hospital plant for the treatment of infectious diseases. It closely adjoins the main hospital group and is under the general management of the Superintendent of the City Hospital. The South Department consists of the following buildings: Administration Building, two Ward Buildings, Domestic Building, Nurses' Home, Mortuary and Laundry, and Gate Lodge. An Isolating Ward Building for surgical cases, and a Measles Ward Building were a part of the original design, but as yet neither of these has been built. The buildings belonging to the hospital proper are the Pathological Building group, consisting of Laboratories, Mortuary, and Mortuary Chapel; an Open Ward Building for Surgical Cases; a Surgical Operating Building; a Boiler and Dynamo House; and an Ambulance Stable.

Situation of the South Department.

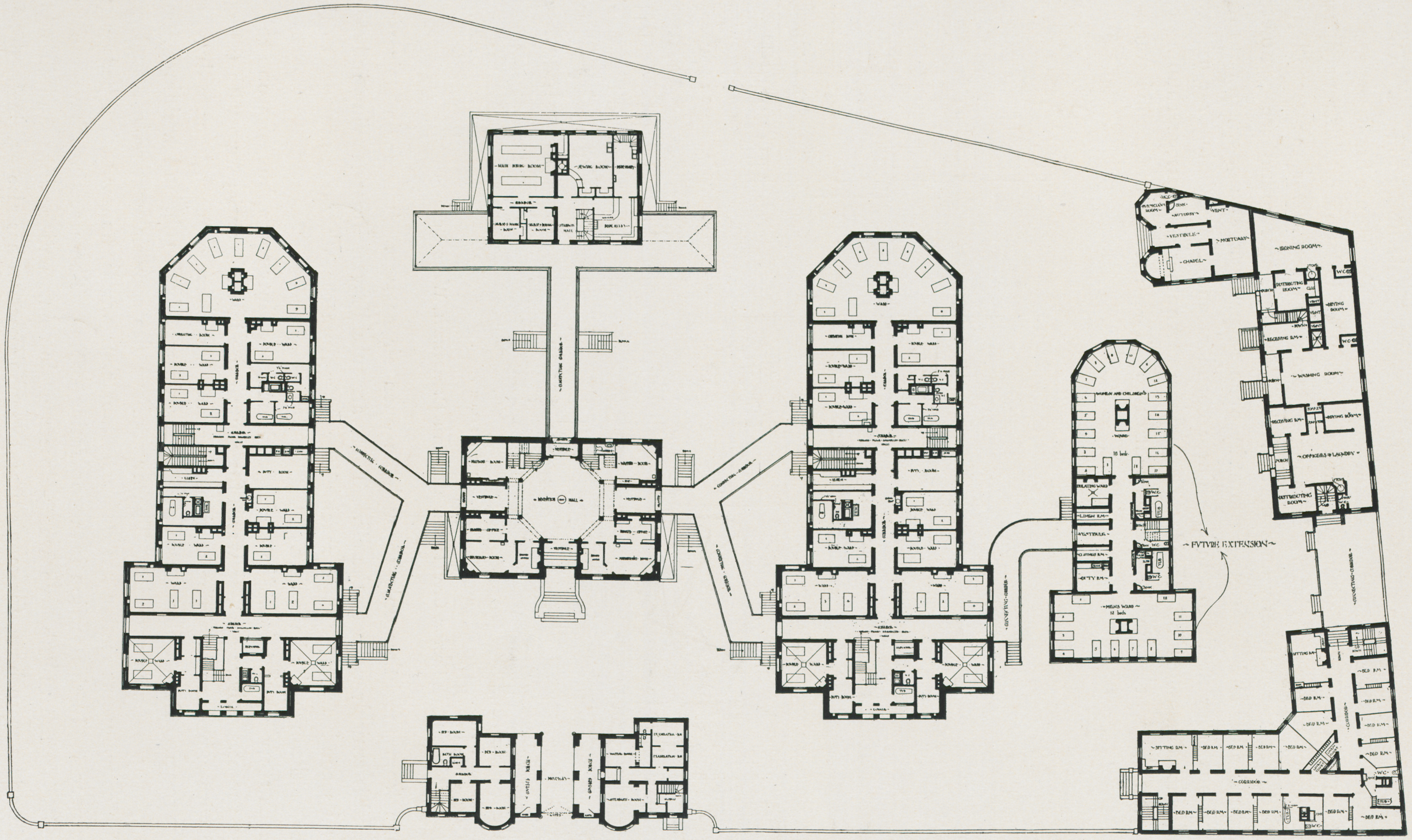
The group of buildings constituting the South Department occupies a lot bounded by Massachusetts avenue, Albany street, Northampton street, and an alley between the lot and a

BOSTON CITY HOSPITAL, SOUTH DEPARTMENT.

block of private houses which front on Harrison avenue. On this restricted site is placed a complete hospital with a minimum capacity of 180 beds which may be easily extended to 224; and still the arrangement is such that no building shadows detrimentally any other building. The lot is enclosed by the Gate Lodge, the Nurses' Home, the Mortuary and Laundry Building, and a brick wall seven feet high capped with marble. The entrance to the grounds is on Massachusetts avenue through the Gate Lodge, in which are the porter's rooms, reception, examination, waiting rooms, etc.

The Administration Building.

The Administration Building is in the centre of the group. On the first floor are the offices of Superintendent, Resident Physician and his assistants, Matron, and reception rooms,

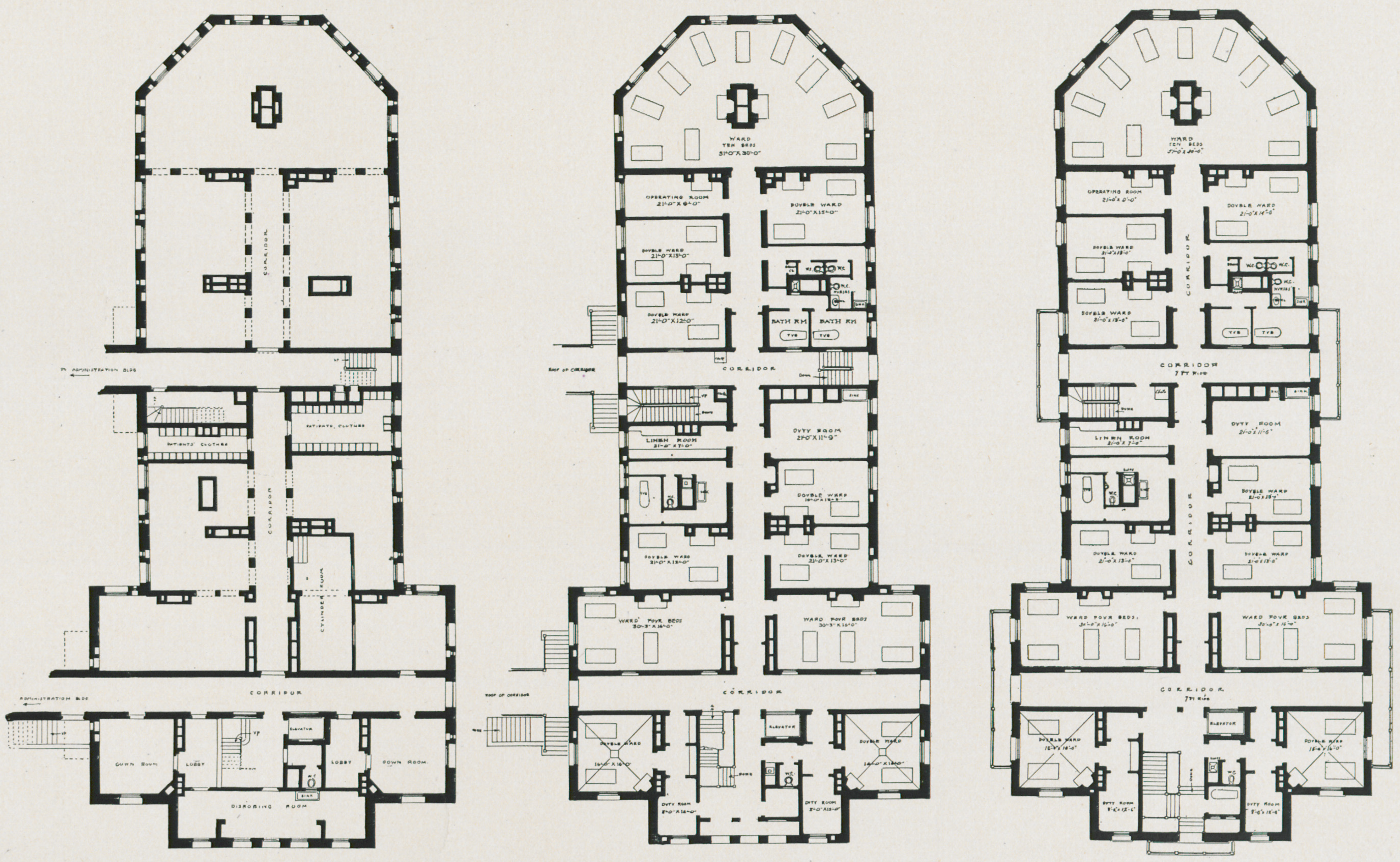


Block Plan of Boston City Hospital, South Department.

etc. On the second floor are the family apartments of the Resident Physician, and, reached by a separate stairway, a group of rooms for Matron and female upper officers. On the third floor are the rooms of the Assistant Resident Physicians and the House Staff.

The Ward Buildings.

The plan of the Ward Buildings is such that absolute isolation of different diseases and different stages of diseases is given. Isolating or probation rooms for the reception of new cases are placed at the northerly ends of these buildings. These rooms are completely shut off from one another and from other rooms by open air passages, one of which runs from east to west, and one from north to south. These corridors and the isolating rooms have walls lined with white enamelled brick and terrazo floors. Another air passage running east and west segregates the acute from the convalescent cases. The first and the second stories can be



BASEMENT PLAN. FIRST FLOOR PLAN. SECOND FLOOR PLAN.

Boston City Hospital, South Department, Ward Building.

reached one from the other only through an open air passage. The main staircase at the northern end is entirely open to the air. There are subsidiary staircases serving independently the first and second stories; and to reach either story from the other one must go to the open air corridor or through the basement.

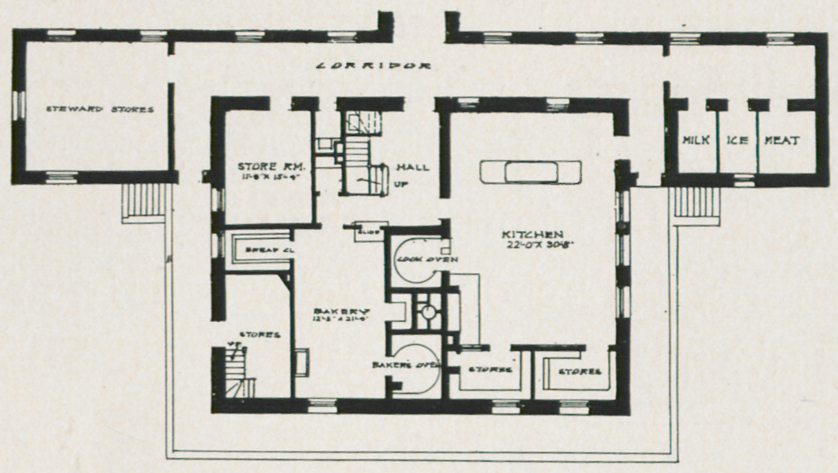
Isolating Wards.

On each story are two isolating wards, each having a duty room, but with one toilet room for the two rooms. There are five wards for acute cases in each story; two with 6 beds each, and three with 4 beds each. The sections for acute cases have on each floor, a duty, a linen, and a toilet room. Each toilet room has a water-closet, a bath tub, and a sink. A urinal is also provided for the men's wards. The nurses have also a special water-closet and toilet set bowl. The convalescent section has on each floor four wards, one with 14 beds, and three with 4 beds each. In this section is the operating room. These sections have each a toilet room fitted with a bath tub, two water-closets, a slop-sink and a sink; and in addition a water-closet and a wash bowl for men's use; the men's section has also a urinal. The broom closets are so placed that they are ventilated into the slop-sink shaft. The toilet rooms in the

Ward Buildings are carefully arranged, both by the arrangement of plan and by the heating and ventilating system, so that any possible passage of foul air to the corridors is prevented. About a ventilation shaft are grouped the water-closets and the slop hoppers. The walls enclosing these fixtures are carried to the ceiling, the other dividing partitions are 7 feet high, and are set one foot above the floor upon brass standards. These partitions are constructed of channel irons and expanded metal lath construction, finishing 1¾ inches and with top and bottom rounded in plaster. The toilet rooms have terrazo floors and marble bases.

Corridor connections.

Basement corridors connect the Administration, Domestic, and Ward Buildings solely for domestic service. The Gate Lodge has no corridor connection with any other building. The Nurses' Home has no connection with any other building. Pipe conduits run underground to the buildings not connected by corridors. In the basement of each Ward Building are robing rooms. Visitors to patients enter by the basement corridors, and go first to one of these rooms, where they put over their street clothes a robe and a head covering. On their return they leave the robe in another room in the basement.



BASEMENT PLAN.

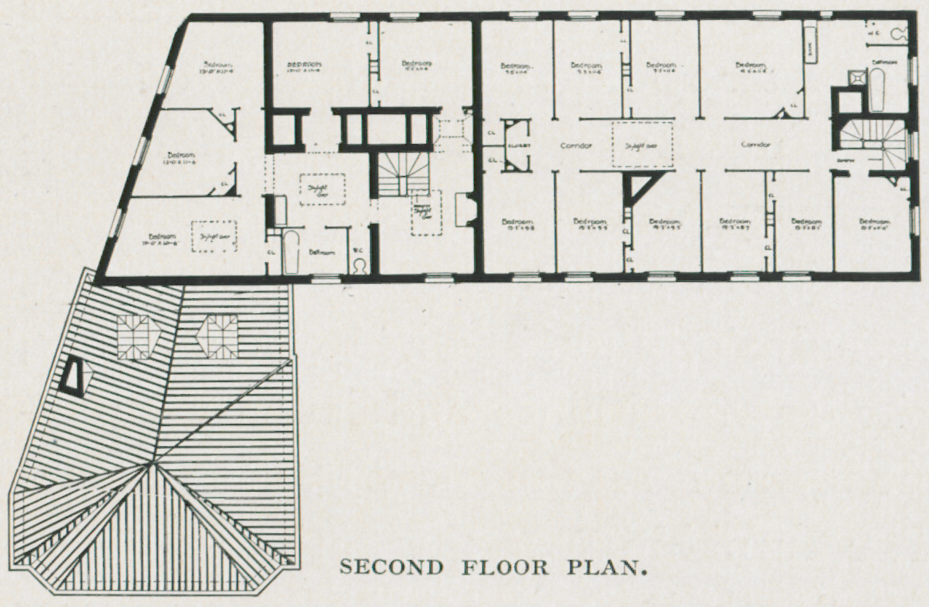
Boston City Hospital, Domestic Building.

Other buildings.

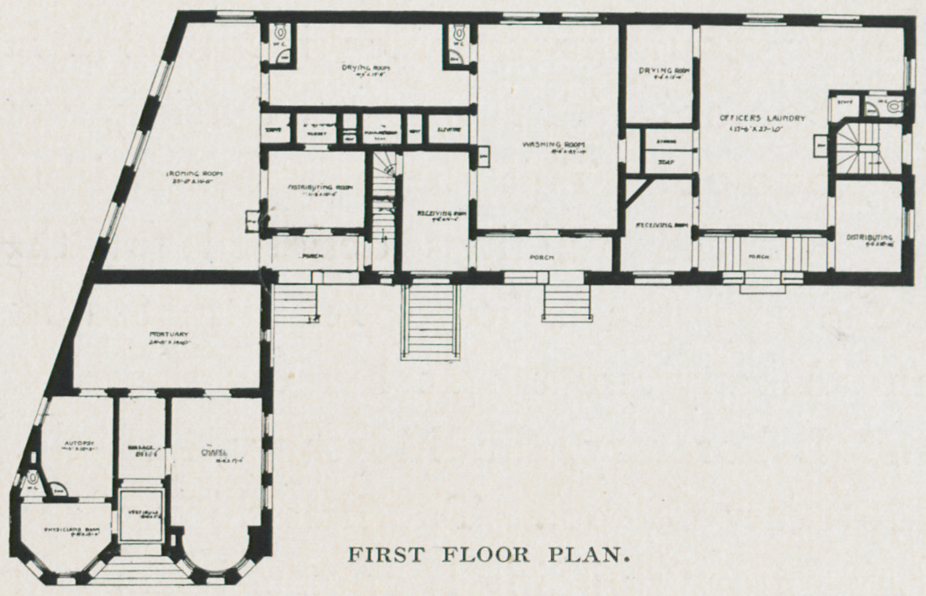
Behind the Administration Building, and connected with it by basement and open upper corridors is the Domestic Building. In the basement of this building are the kitchen, the bakery, and milk, ice, and steward's store rooms. On the first story are dining and serving rooms, the dispensary and the serving rooms. The Nurses' Home is so arranged that absolute seclusion can be given the two sections of the building, each having a separate sitting room and a separate toilet room. There are in this building accommodations for fifty-six nurses in single rooms. Each story is accessible by iron stairways outside the nurses' rooms, and practically may be used by nurses attendant upon different infectious diseases without their coming in contact with each other. The large aspirating shaft in the Laundry Building is designed for the ventilation of the future one story Measles Ward Building shown upon the block plan.

Main features of construction.

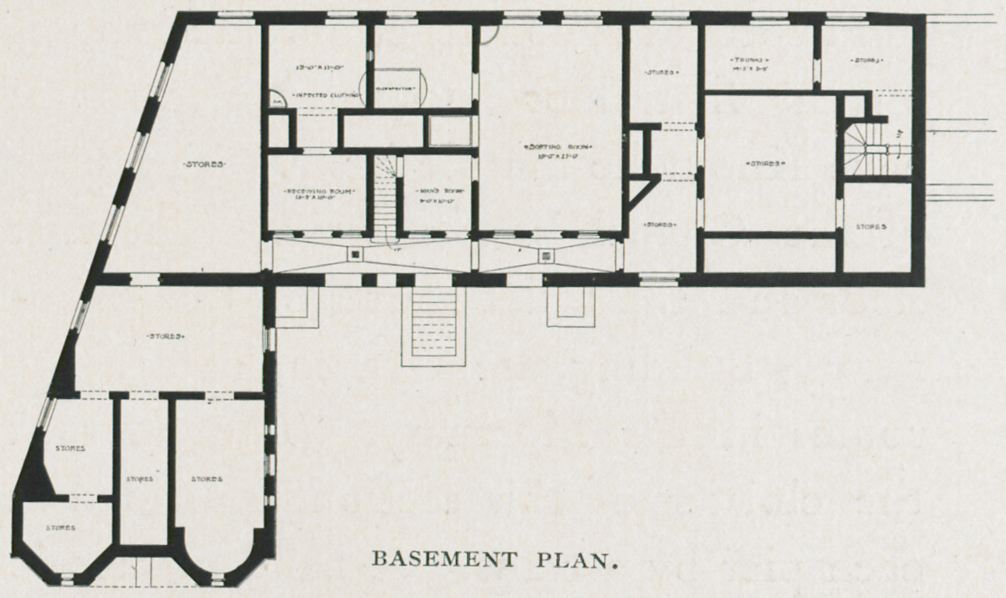
The constructive features of these buildings are in the main those to be found in all the Boston City Hospital buildings designed by Mr. Wheelwright. They have pile and block granite foundation. With one exception, the buildings are of water struck brick with white marble trimmings. The Surgical Operating Building, which was in part a reconstruction of an old building, is of face brick with granite trimmings. Except in this building and the Ambulance Stable, the basement walls, the arch, and the



SECOND FLOOR PLAN.



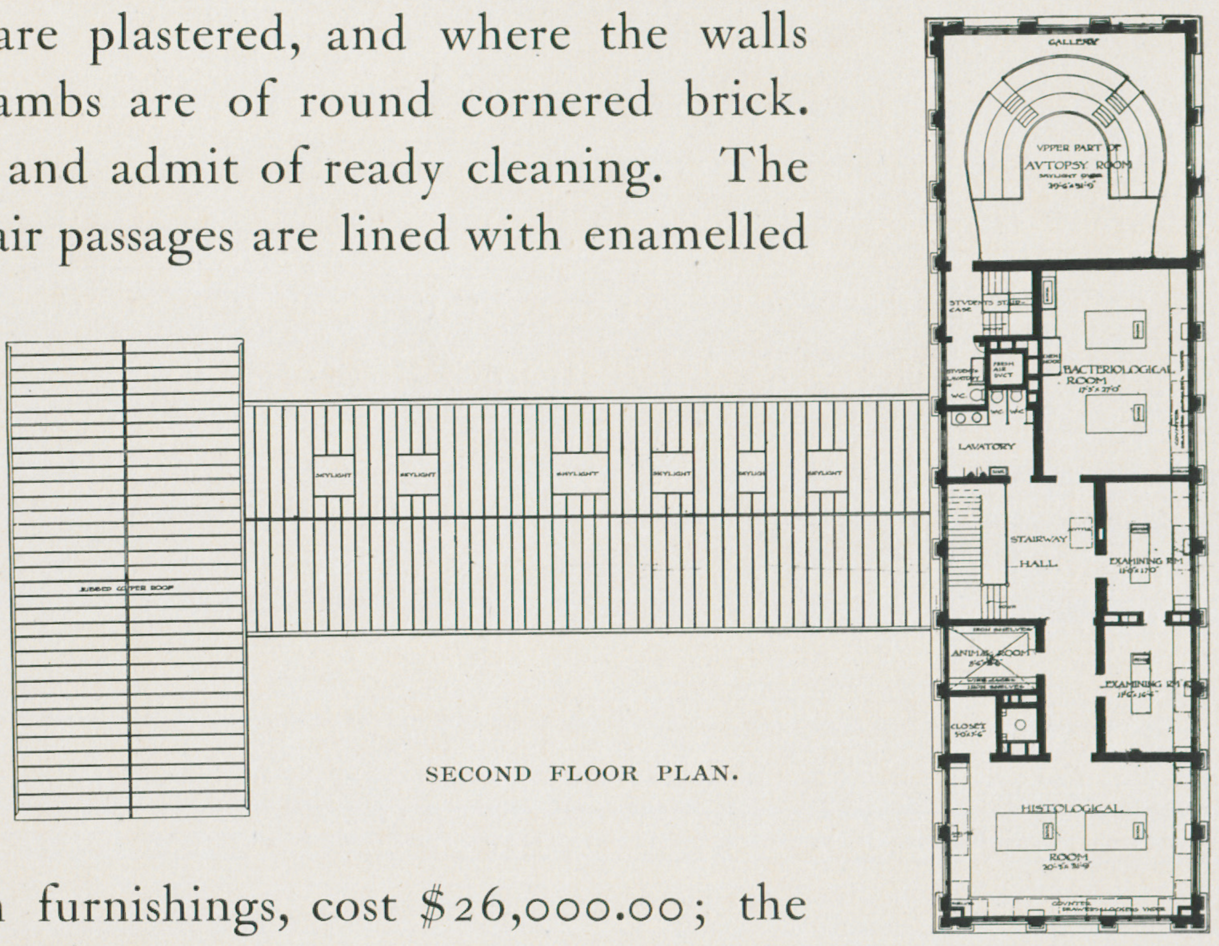
FIRST FLOOR PLAN.



BASEMENT PLAN.

Boston City Hospital, South Department, Mortuary and Laundry Building.

quoins are laid in red mortar, the rest of the brickwork being laid Flemish bond in white mortar. The exterior steps are of bluestone. The underpinning and the belt course at the first floor level are of granite. The tops of the connecting corridors are of slate tile. The external walls are laid with an air-space and with an inner lining of hollow brick upon which the plastering is directly laid. Non-weight bearing partitions are either of terra cotta blocks or of channel iron and expanded metal lathing, finishing when plastered 1¾ inches. The ceilings of wood construction are wire lathed, except in unfinished rooms in the basement, where the mill construction flooring is exposed and whitewashed. The plastering is of Windsor cement. All angles of walls and ceilings are coved. The bases of rooms with wood floors are coved, while those with marble, terazo, or mosaic flooring are of Knoxville marble which are also coved. The Georgia pine floors are matched and blind nailed. Where used they have been adopted advisedly, because floors of harder substances have proved to be injurious to the nurses' feet. As far as possible wood has been avoided in the standing finish. The door and wood trims are of Keene's cement where the walls are plastered, and where the walls are of unplastered brick all angles and jambs are of round cornered brick. The iron staircases are of a simple design and admit of ready cleaning. The staircase treads are of marble. All outer air passages are lined with enamelled brick and have terrazo floors. The roofs are of tar and gravel, except portions of the Gate Lodge and the roof of the Mortuary, which are of copper.

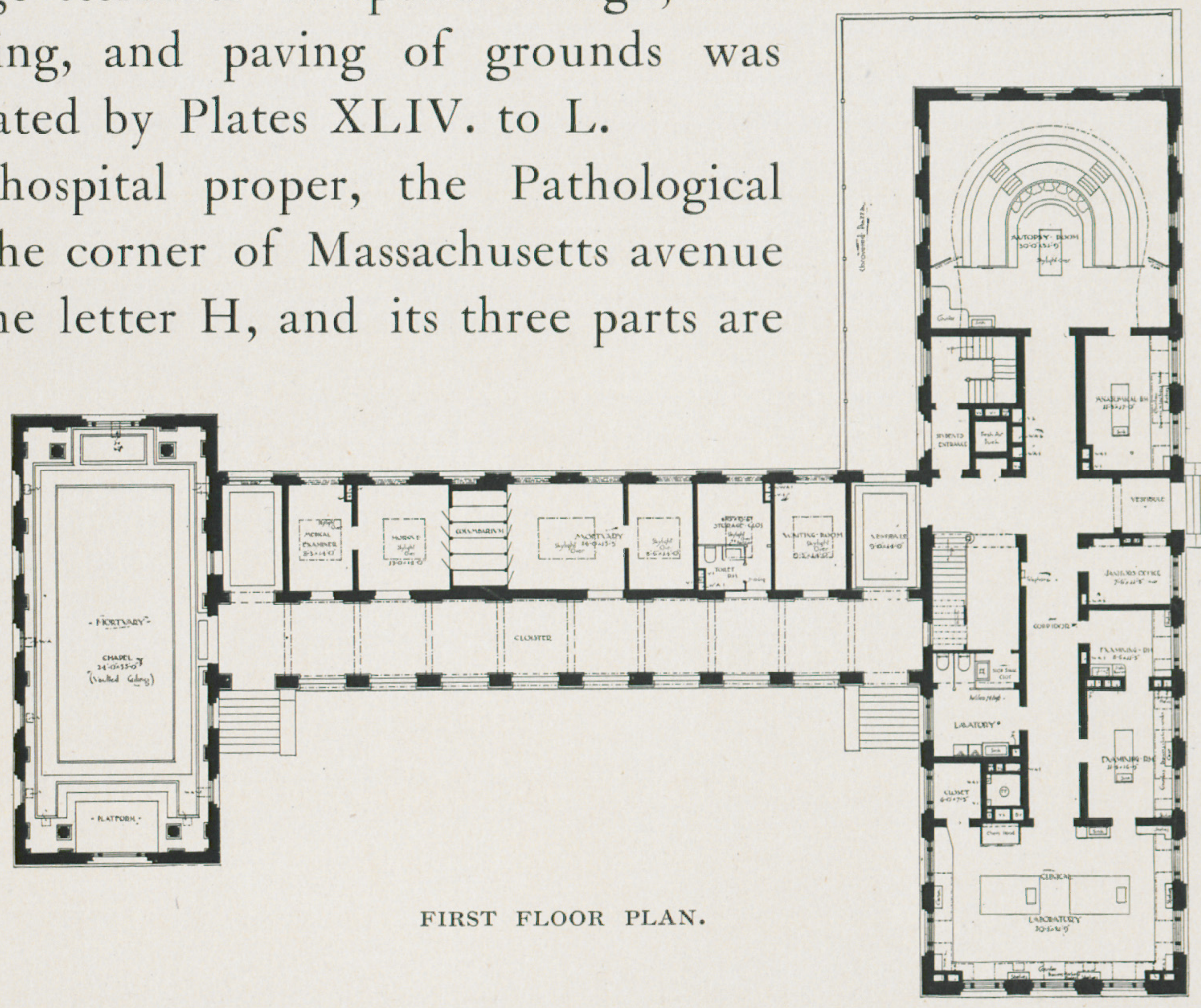


SECOND FLOOR PLAN.

The cost of this group of buildings, exclusive of plumbing and electric work, kitchen furnishings and laundry equipment, and heating, was $438,000.00. The furnishings of the entire group of the South Department, including kitchen furnishings, cost $26,000.00; the laundry equipment, which included a large sterilizer of special design, cost $13,600.00. The cost of fencing, grading, and paving of grounds was $27,000.00. This group is further illustrated by Plates XLIV. to L.

The Pathological Building.

Of the buildings designed for the hospital proper, the Pathological Building is the largest. It is situated at the corner of Massachusetts avenue and Albany street. It has the shape of the letter H, and its three parts are the Laboratory, the Mortuary, and the Mortuary Chapel. The first floor of the Laboratory Building is of steel beam and terra cotta arch construction. The rooms on the first floor and the toilet rooms have Knoxville marble bases. The floor of the Chapel is of mosaic. The first floor and the toilet rooms of the Laboratory Building are terrazo, as are the rooms in the Mortuary. The floor in the cloister of this section is divided at each pier by a transverse band of mosaic laid before the terrazo. This method of constructing a terrazo floor was adopted to prevent the inevitable cracking of concrete construction when such material is laid in large surfaces and on reclaimed ground, and has proved to be a



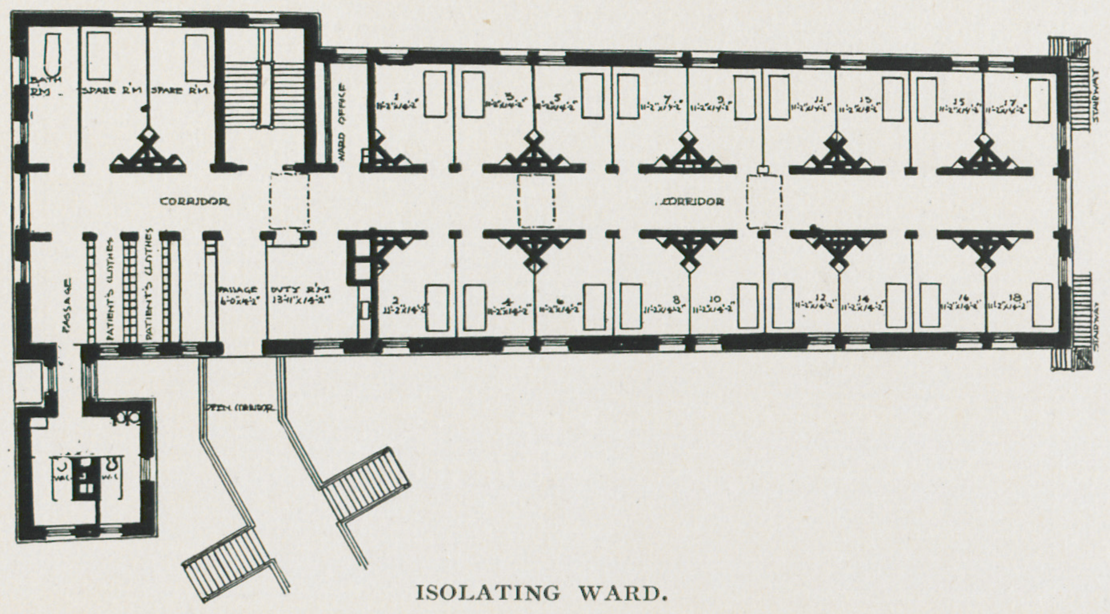
FIRST FLOOR PLAN.

Boston City Hospital, Pathological Building.

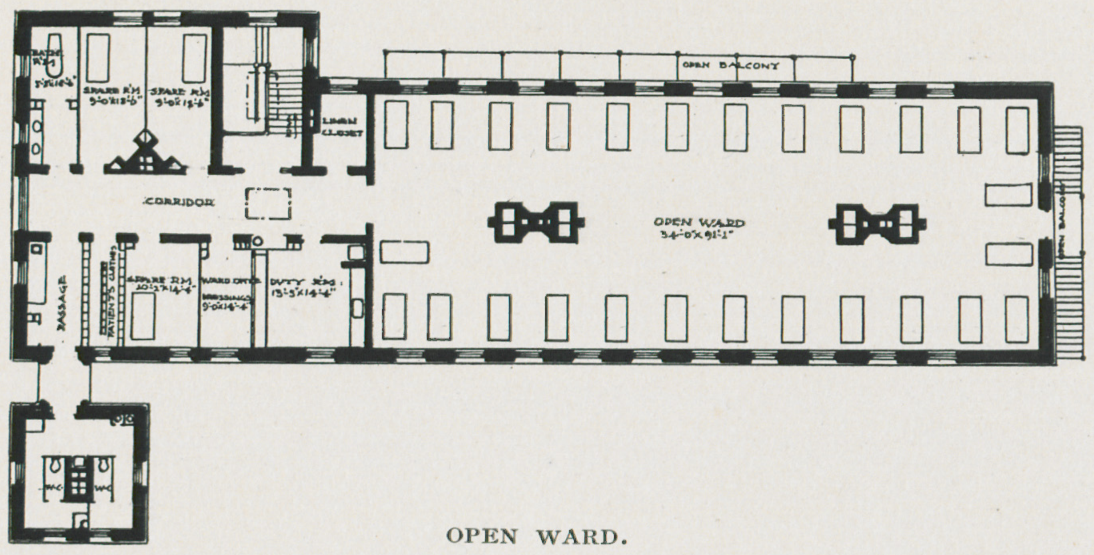
successful expedient. The interior finish of the Chapel is of plaster and Keene's cement with white Italian marble base, and with steps and wall panels of the same material. The roof of the Laboratory is covered with dark blue slate; and the roofs of the Mortuary and the Chapel are of copper. The cost of this building, including plumbing and electric work and the laboratory fittings, but not including heating, was $92,000.00. This building is further illustrated by Plates LII. to LVIII.

Open Surgical Ward Building.

The Open Surgical Ward Building has a capacity of 59 beds for adults. Its main constructive features are like those of the South Department Ward Buildings, except that all jambs of doors and windows in the plastered rooms as well as in the basement are of round cornered brick, and that Keene's cement trims of doors and windows are not used. The cost of this building, including plumbing and electric work, but not including heating, was about $65,000.00. See also Plate LI.



ISOLATING WARD.

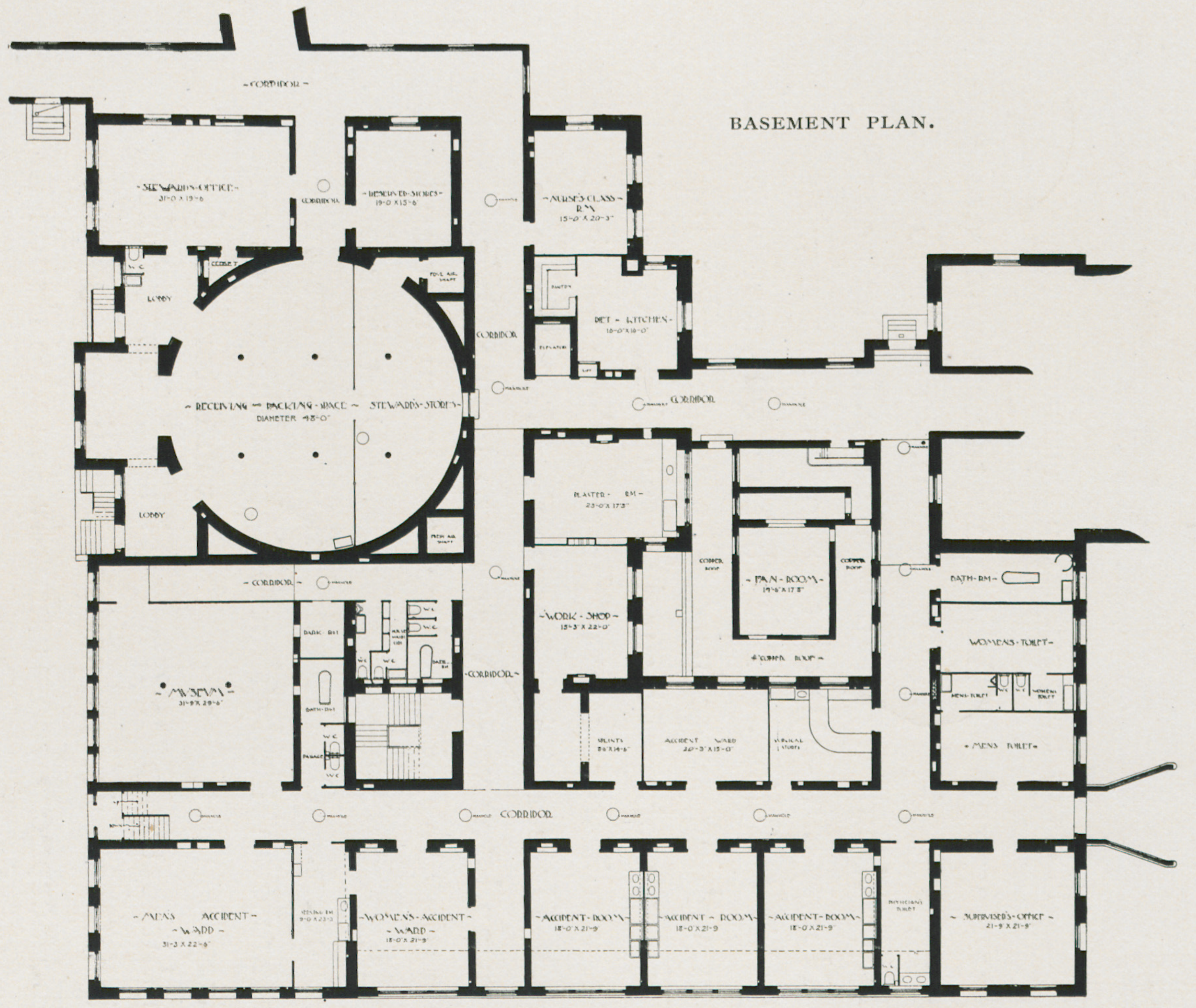


OPEN WARD.

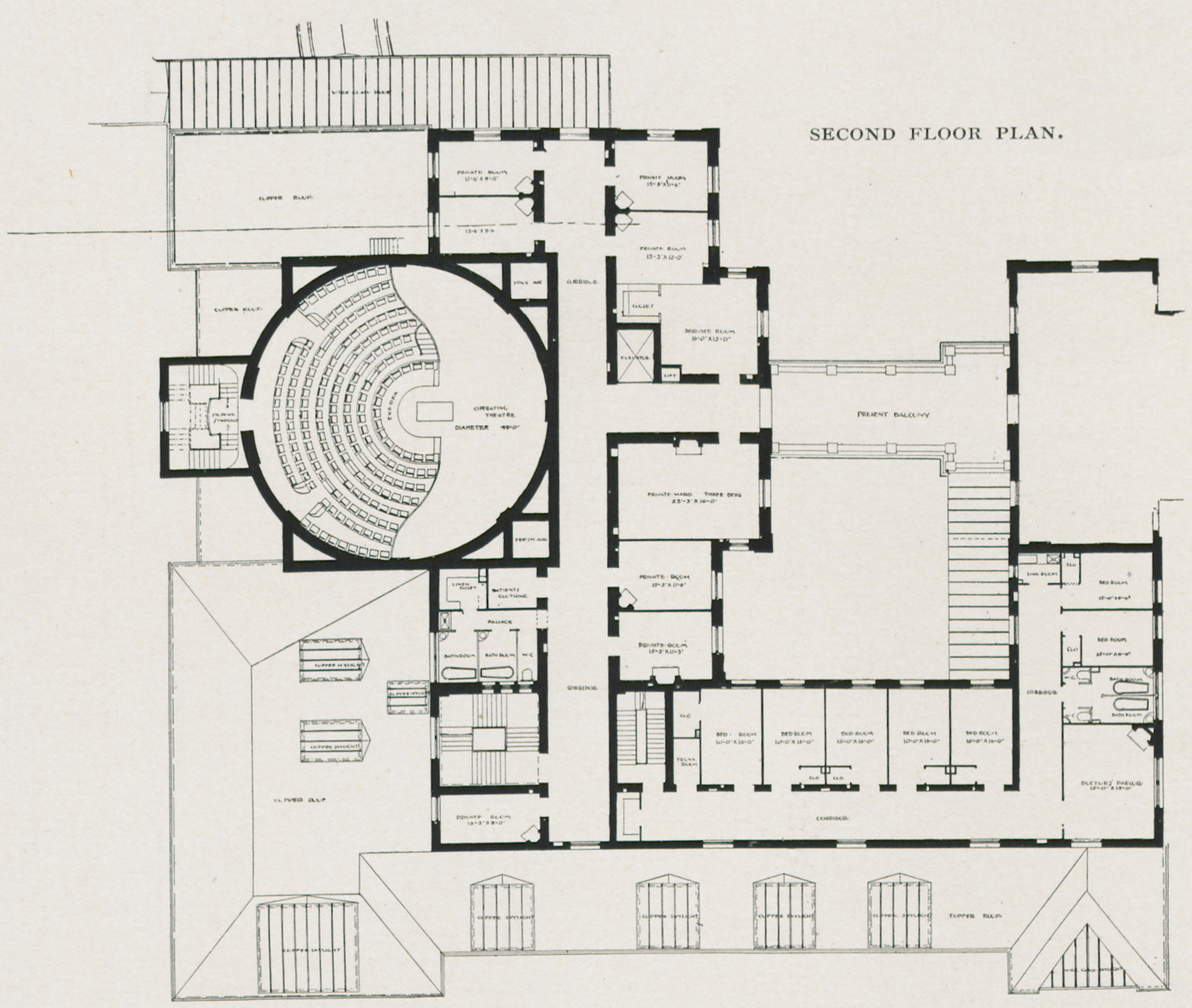
Plans of Surgical Ward Building.

The Surgical Operating Building.

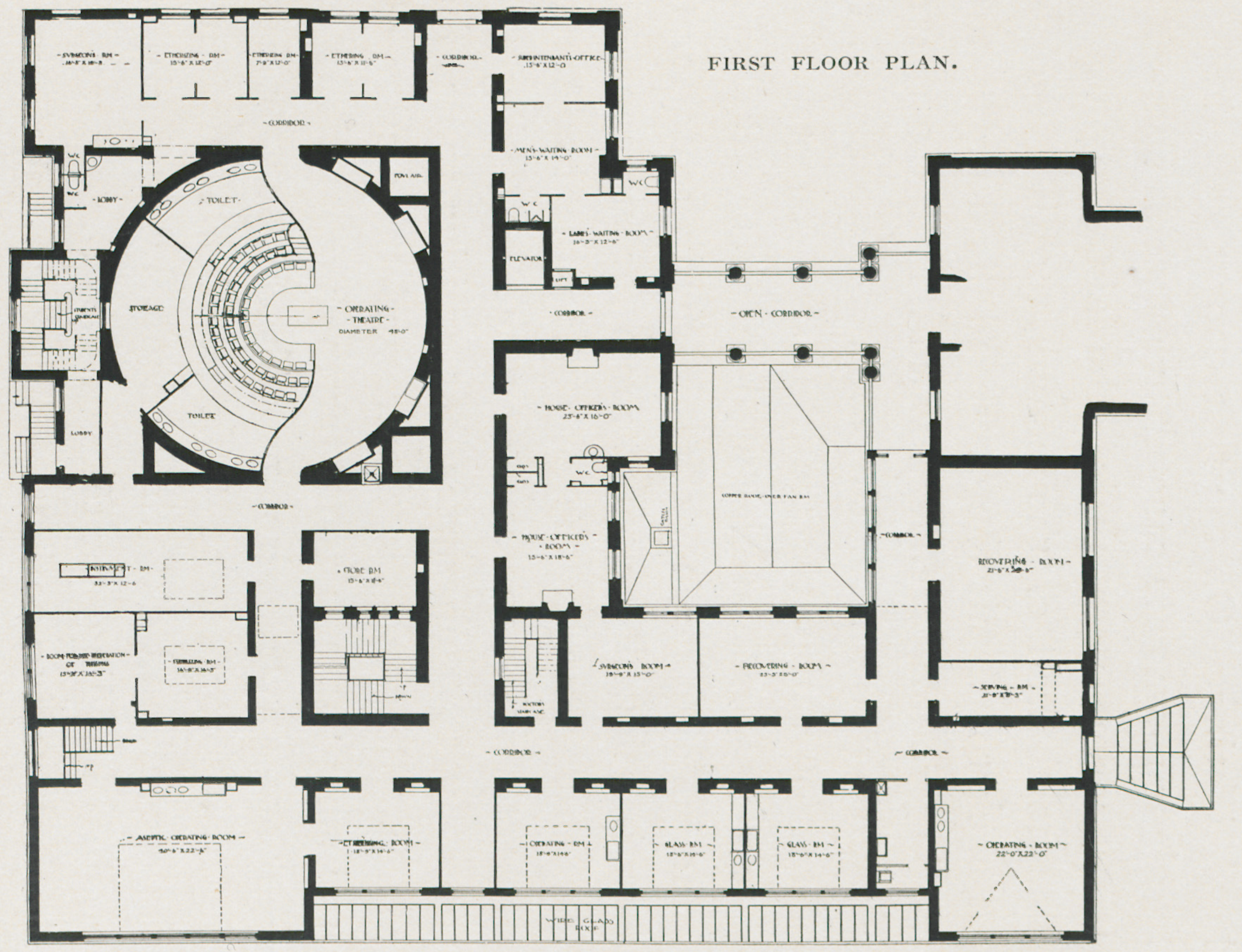
The Surgical Operating Building is in part a reconstruction of an older building built for the same purpose. The lower floor walls are built entirely free from the ground, and the ambulance approach is at the lower level. On the north side of this basement are ranged the accident rooms, waiting rooms, and two casualty wards, which are lighted by large wall windows and by skylights. The wall of the first story is set back from the north basement wall to permit of this overhead lighting. On the first floor above the accident rooms are ranged five special operating rooms with their etherizing rooms. The north wall of the second story is again set back to permit the overhead lighting of the operating room. Adjoining these rooms are waiting rooms, recovery wards, and wash, sterilizing, and instrument rooms, as well as a consulting room for surgeons. Here also is the large circular operating theatre. The roof of the operating theatre is of steel construction. Nearly one-half of this roof is glazed with wire glass, the material used in all the skylights of this building. The theatre will seat one hundred and seventy students, with seats for fifteen visiting surgeons. The space under the seats is utilized for toilet room for surgeons, and for the storage of surgical supplies. On the lower floor, under the operating theatre, are the steward's store rooms for the whole hospital. Five etherizing rooms adjoin the operating theatre. Here also is a surgeon's private room, a room for the superintendent, waiting rooms for men and for women, and two Home Officers' rooms. Between the theatre and the section of operating rooms are placed the instrument and sterilizing room, a room for the preparation of bandages, and one for storage. On the second floor are seven bedrooms and a parlor for Home Officers. On the third floor there are nine bedrooms for Home Officers. These apartments are completely shut off from the wards on the second and the third floors by a special stairway. That part of the second story of the original building not taken up by the operating amphitheatre space is a special ward for private surgical paying patients. There are accommodations for thirteen patients. All rooms have fireplaces, and there are the duty, linen, clothes, and accessory rooms usually found in such a



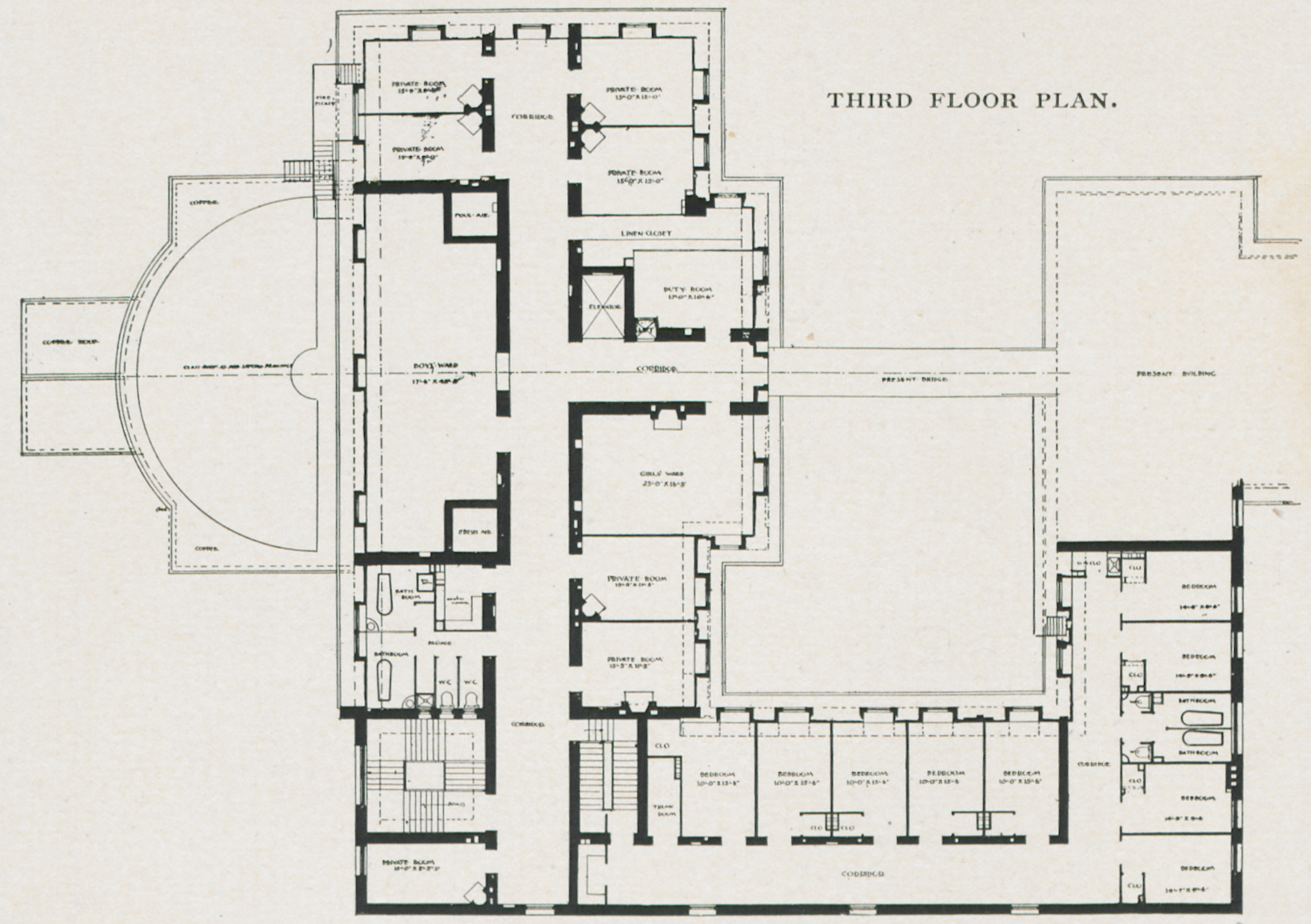
BASEMENT PLAN.



SECOND FLOOR PLAN.



FIRST FLOOR PLAN.



THIRD FLOOR PLAN.

Boston City Hospital, Surgical Operating Building.

ward. The wards on the third floor are for women and children. A roof playground, enclosed by a high iron fence, is provided for patients of either second or third story, and is accessible by elevator or stairway.

The lower floor of this building is of terrazo laid upon concrete bed. The first story floor is of steel and terra cotta arch construction with terrazo upper floor. All terrazo and mosaic floors are divided into sections of not more than 10 feet in length or breadth by Knoxville marble strips to prevent the cracking of these surfaces. Operating theatre, operating and subsidiary rooms, and corridors have Knoxville marble bases with dust corners. The dado in the theatre is of Knoxville marble and is 10 feet high; in the operating rooms it is 5 feet high. The treads and platforms of the operating theatre are of Knoxville marble.

The cost of this building, exclusive of heating and ventilation, was, according to contracts made up to July 1, 1895, about $166,000.00. This building was one of those unfinished when the Architect Department was abolished; and at present (June, 1898) it is still uncompleted.

The Boiler and Dynamo House.

The Boiler and Dynamo House is on the east side of Albany street, immediately adjoining the Boston City Hospital wharf, where a coal pocket has recently been built to permit of the direct delivery of coal from vessels. In this building are the boilers and the electric plant which serve all the hospital buildings. In the second story there are sleeping rooms for male employees. The building is on pile foundations. The exterior is of selected water-struck brick, laid Flemish bond in white mortar; the trimmings are of white marble. The interior finish is of ash. The cost was about $30,500.00, exclusive of the cost of the pipe conduit.

This building is illustrated in Plates LX. and LXI.

The Ambulance Stable.

The Ambulance Stable adjoins the Boiler and Dynamo House and is of similar construction, except that the brickwork is laid in red mortar, and that the trimmings are of long-meadow stone. The cost of the building was about $26,000.00.

This building is illustrated in Plate LIX.

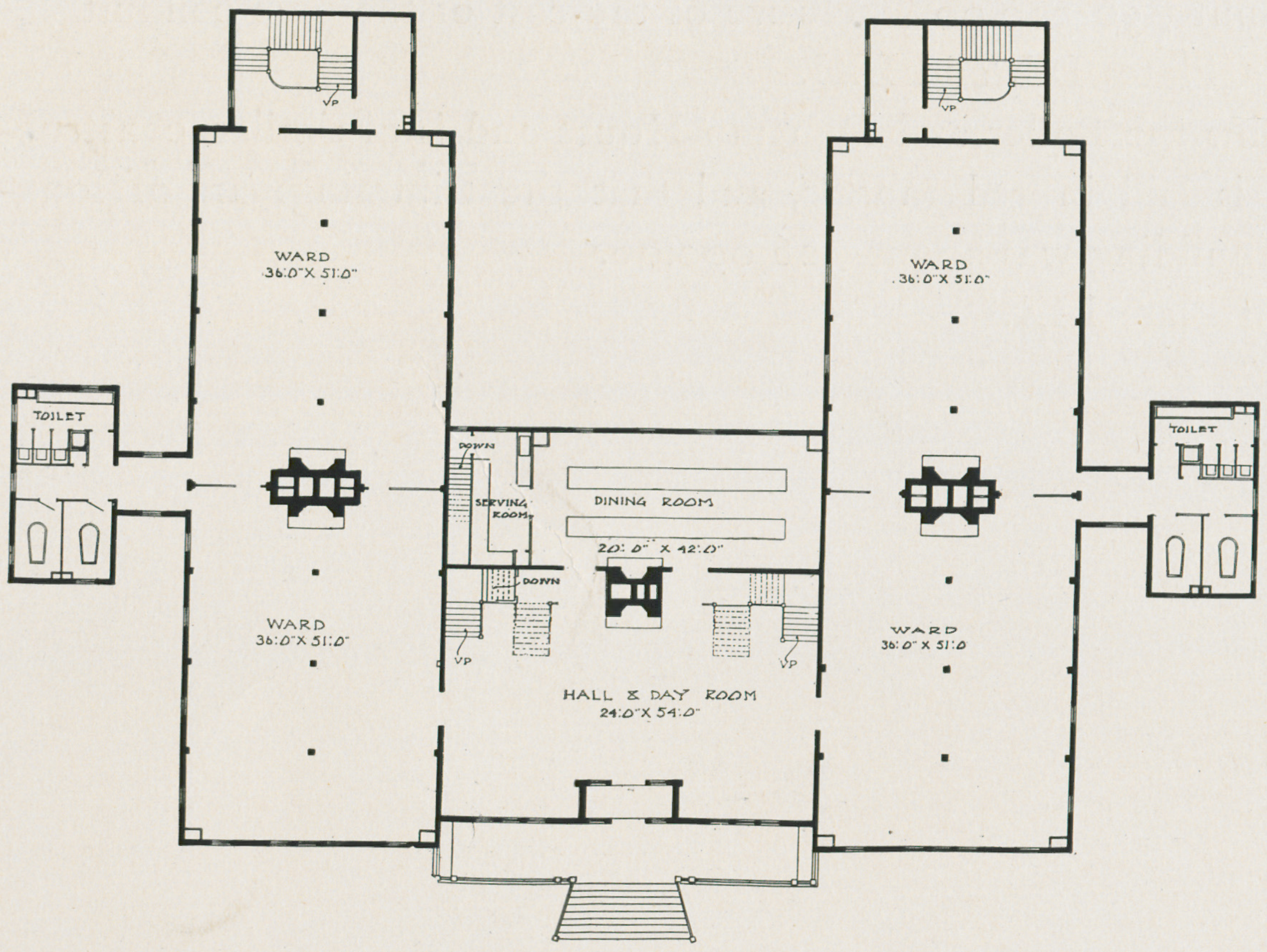
III.

Other Institutional Buildings.

MR. WHEELWRIGHT designed for the Institutions Department of the City of Boston a Dormitory for Women and a Hospital on Long Island, buildings for the Boston Lunatic Hospital at Austin and Pierce Farms, and buildings for the Parental School for Boys.

Dormitory for Women, Long Island.

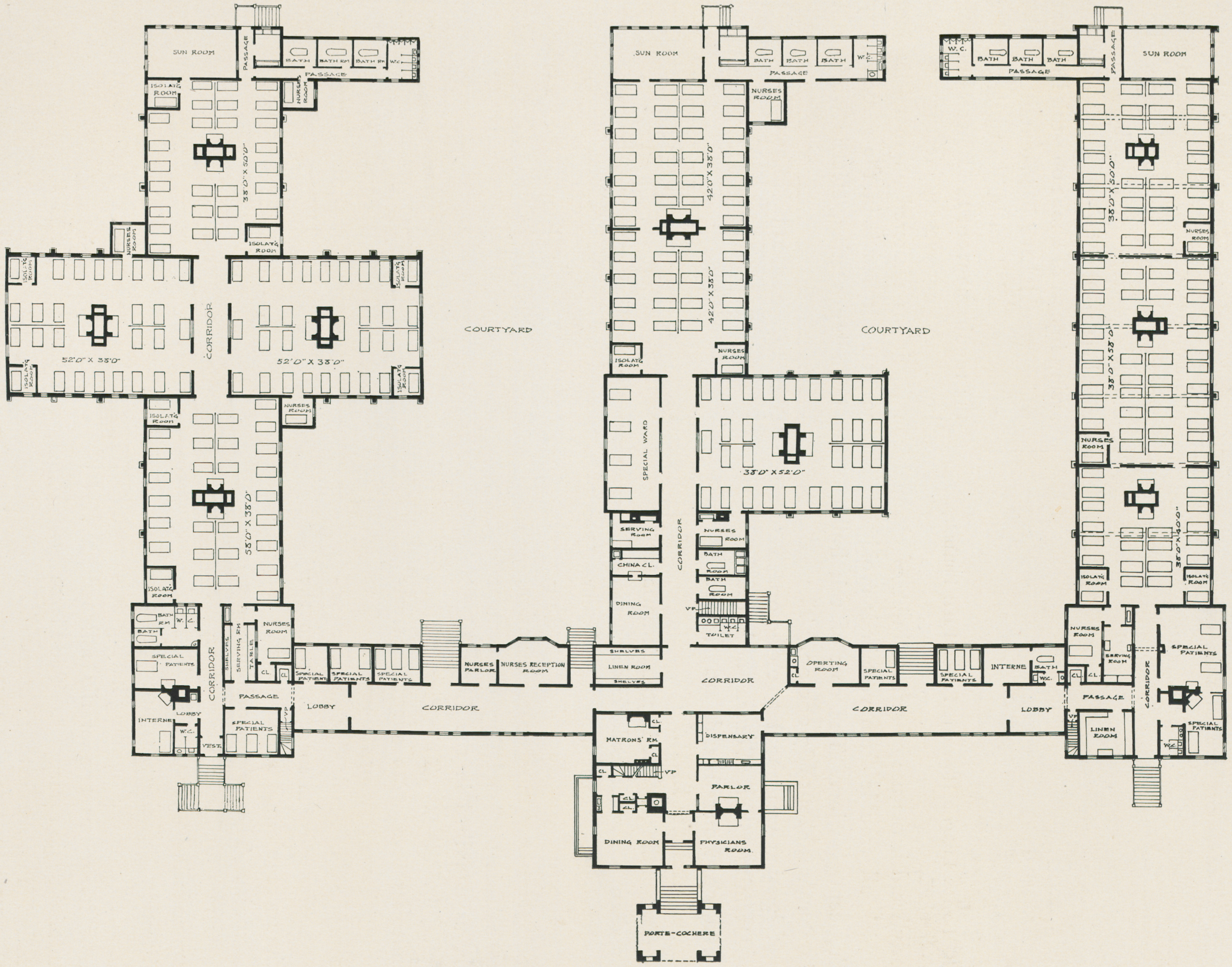
Of the Dormitory for Women only the first floor plan is here shown. The second floor is practically a repetition of the first, except that on the second are a Sewing Room, 42 feet by 20 feet, and an Officers' Dining Room, 11 feet by 20 feet, which take the location of that of the general Dining Room and Serving Room on the first floor. In the basement of the building are the Office, the Receiving Room for inmates with Clothes Rooms adjoining, and the Kitchen with Pantry and Store Rooms, the remaining space being used for rainy day recreation rooms and general storage. On the first floor the undesignated rooms at the ends of two of the wards are sleeping rooms for attendants. In this building, with the terra cotta lumber construction a light steel frame combined with timber construction was employed, so that the possibility of trouble from shrinkage might be lessened. The details of construction and the interior finish of this building are those found in the easterly wing of the Long Island Hospital. The cost, not including heating or electric work, was $40,000.00.



DORMITORY FOR WOMEN, LONG ISLAND, FIRST FLOOR PLAN.

Hospital, Long Island.

The Long Island Hospital is provided with 287 beds for the sick poor. It is practically a home for chronic cases, rather than a true hospital. The wards are placed in three consecutive wings, divided into large wards, isolating rooms, and small wards for special cases. Connected with each wing are bath rooms and water closets, the principal groups of these fixtures being in separate wings at the end of each pavilion. At the end of each pavilion is a sun room connected with a ward. The Administration Building and the westerly wing were the first to be designed. The wards in this wing give an inadequate air space per patient.



Long Island Hospital, First Floor Plan.

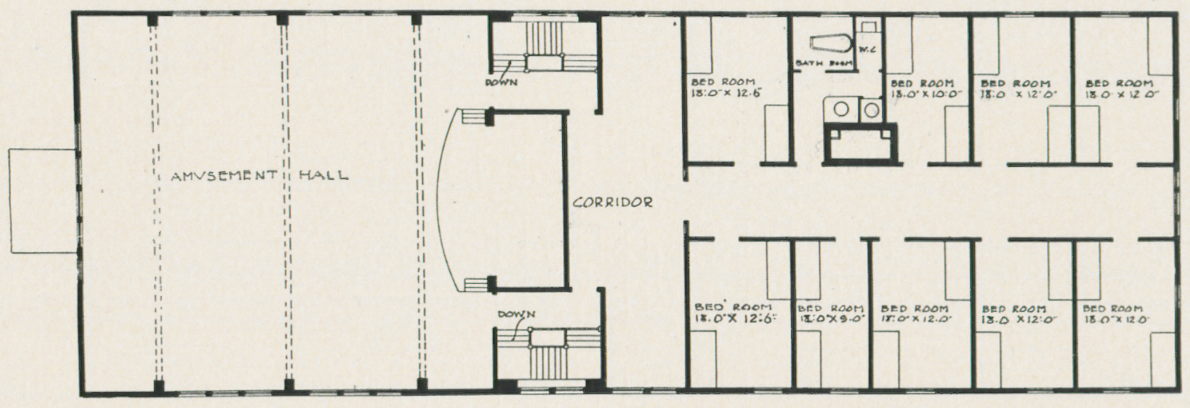
The improvement on the plan of the central wing later built is noticeable. Still further improvement is shown in the easterly wing, which was built last of all. In this building Mr. Wheelwright used for the first time a frame construction filled with terra cotta lumber, plastered directly on the blocks externally and internally. The exterior plastering is Portland cement. The floors are of mill construction. The roofs are covered with 2 inch plank and shingles. The interior finish is of cypress with floors of Georgia pine. The timber and terra cotta lumber construction here used is judged to have made a saving in cost of about one-third of that which would have been entailed if the buildings had been built of brick under the requirements of the Boston building laws. A noteworthy feature of the easterly ward is the use of screens built of channel iron partitions plastered on metal lathing, by which all trouble from vermin is avoided. The hospital kitchen is in the second story of the central wing. The cost of this building, not including heating, electric work, and equipment, was about $87,000.00. The cost of heating was about $10,000.00. The Dormitory for Women and the Hospital on Long Island are further illustrated by Plate LXII.

Boston Lunatic Hospital, Pierce Farm Buildings.

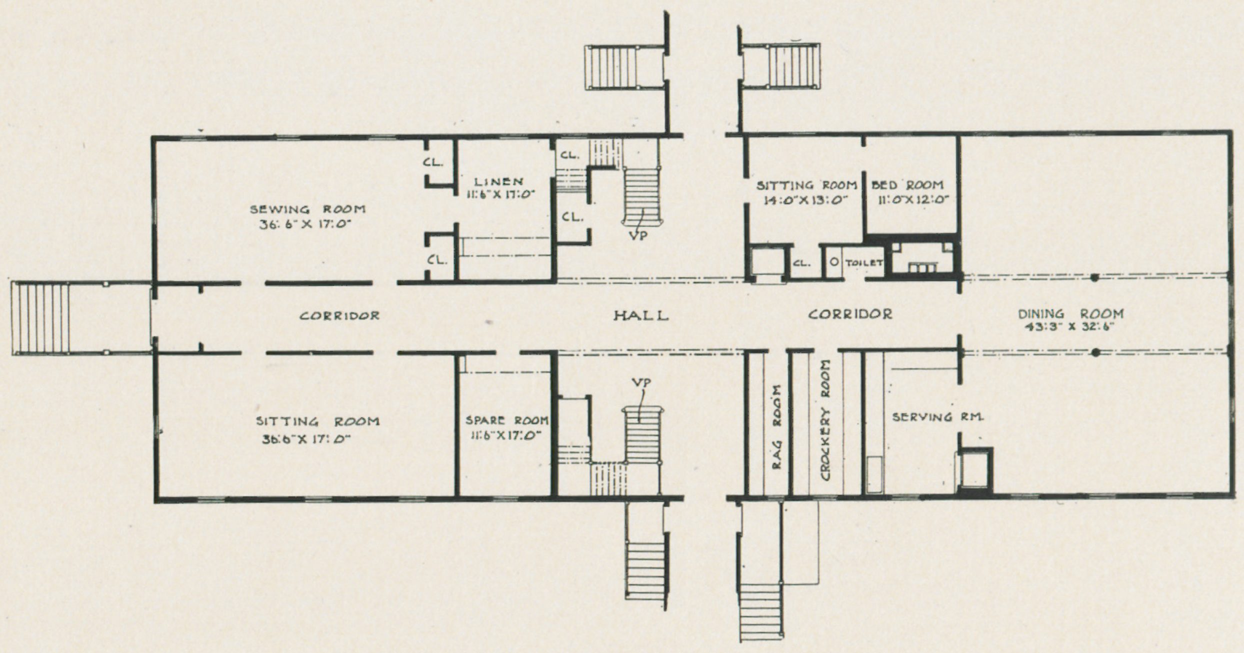
The Boston Lunatic Hospital, Pierce and Austin Farms.

The buildings of the Boston Lunatic Hospital are on Austin and Pierce Farms, West Roxbury. Excepting the boiler houses, they are constructed of the timber and terra cotta lumber construction, with "half-timber" and Portland cement finish, as described in the Long Island Hospital buildings. The Pierce Farm Dormitories present an adequate treatment of a dormitory for the insane. The bedrooms are of ample size and the proportion of day room space is up to the maximum requirements demanded by the best experts. There are two dormitories, one for men and one for women, each accommodating 85 patients. The Administration Building has not yet been built, the Domestic Building having certain of its rooms temporarily assigned for administration purposes. The Pierce Farm buildings are further illustrated by Plates LXIII., LXIV. and LXV.

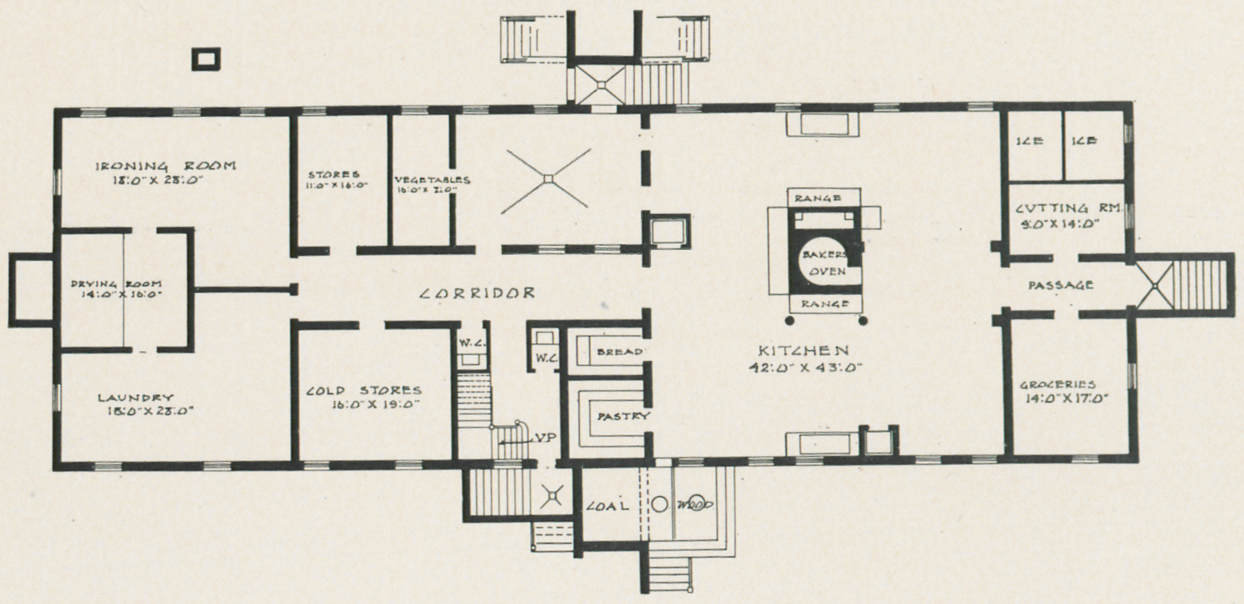
The Dormitory at Austin Farm which was begun in 1891 is illustrated by Plate LXVI. The plan of this building



Second Floor Plan.

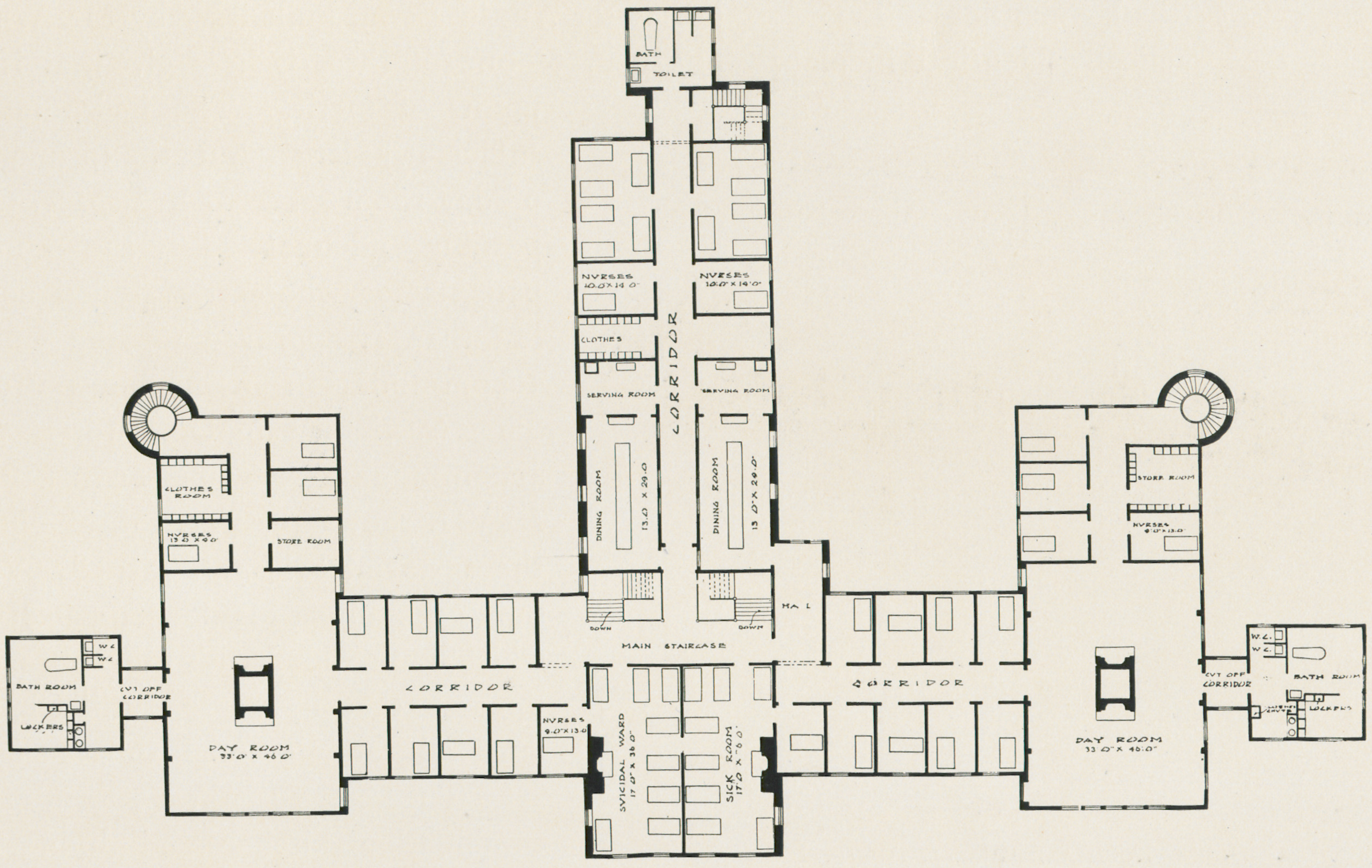


First Floor Plan.

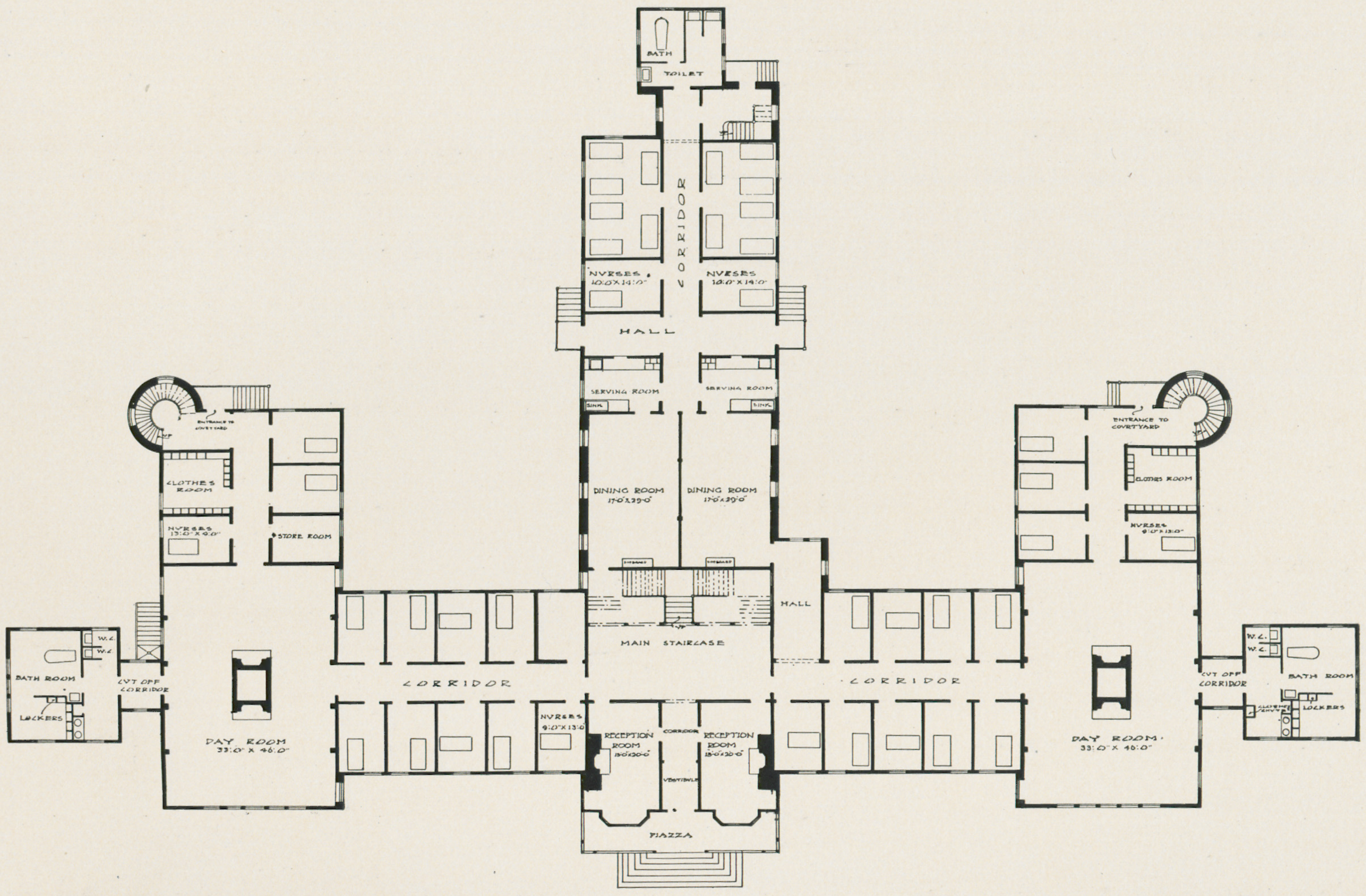


Basement Plan.

Boston Lunatic Hospital, Pierce Farm, Domestic Building.



SECOND FLOOR PLAN.



FIRST FLOOR PLAN.

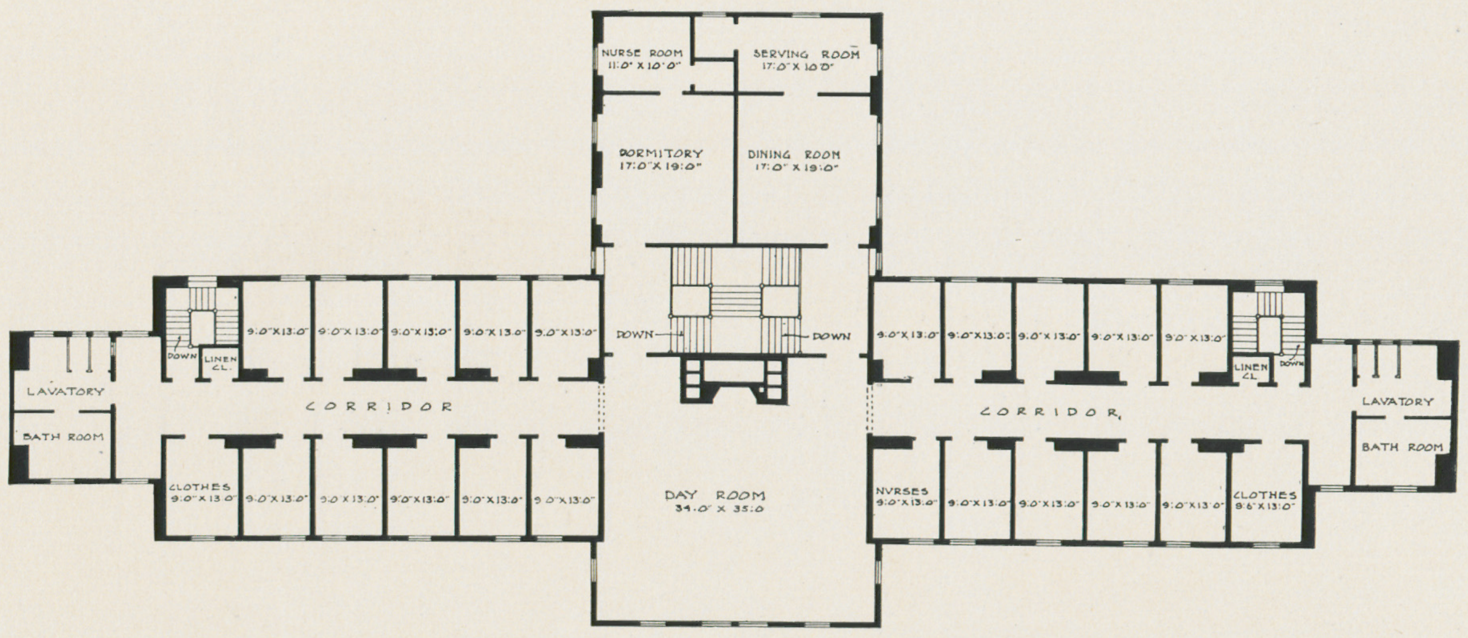
Boston Lunatic Hospital, Pierce Farm, Dormitory.

deserves no particular mention. Two dormitories for Austin Farm, built later by Mr. Wheelwright, are practically identical in plan. The plan of one of these is here given, as it has points of merit. The bedrooms are sufficiently large, but the proportion of day room space to bed space, while possibly adequate for the chronic patients for whom it was designed, is less than is approved for the general accommodation of insane patients. The Austin Farm Dormitories each accommodate 46 patients. Plate LXVII. shows the exterior of one of these dormitories. Plate LXVIII. shows the dining room at Austin Farm, which is provided with movable partitions so that it can be utilized as a large hall for amusement or as a chapel.

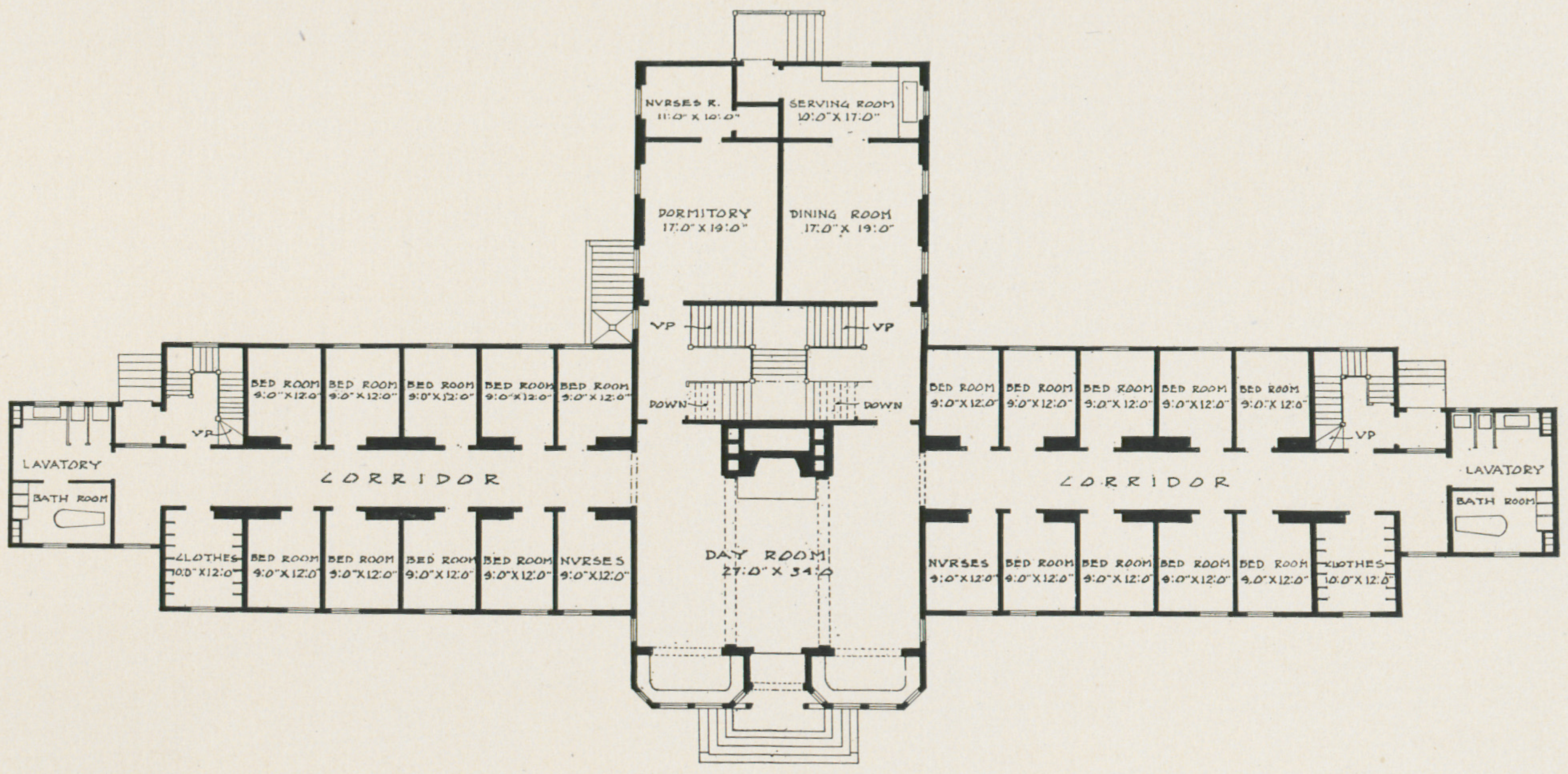
Dining Room and Chapel, Austin Farm.

Cost.

The cost of three dormitories, combination kitchen and dining hall and chapel with connecting corridors, boiler house and laundry at Austin Farm, and two dormitories, domestic building with connecting corridors, and boiler house at Pierce Farm, not including heating and equipment but



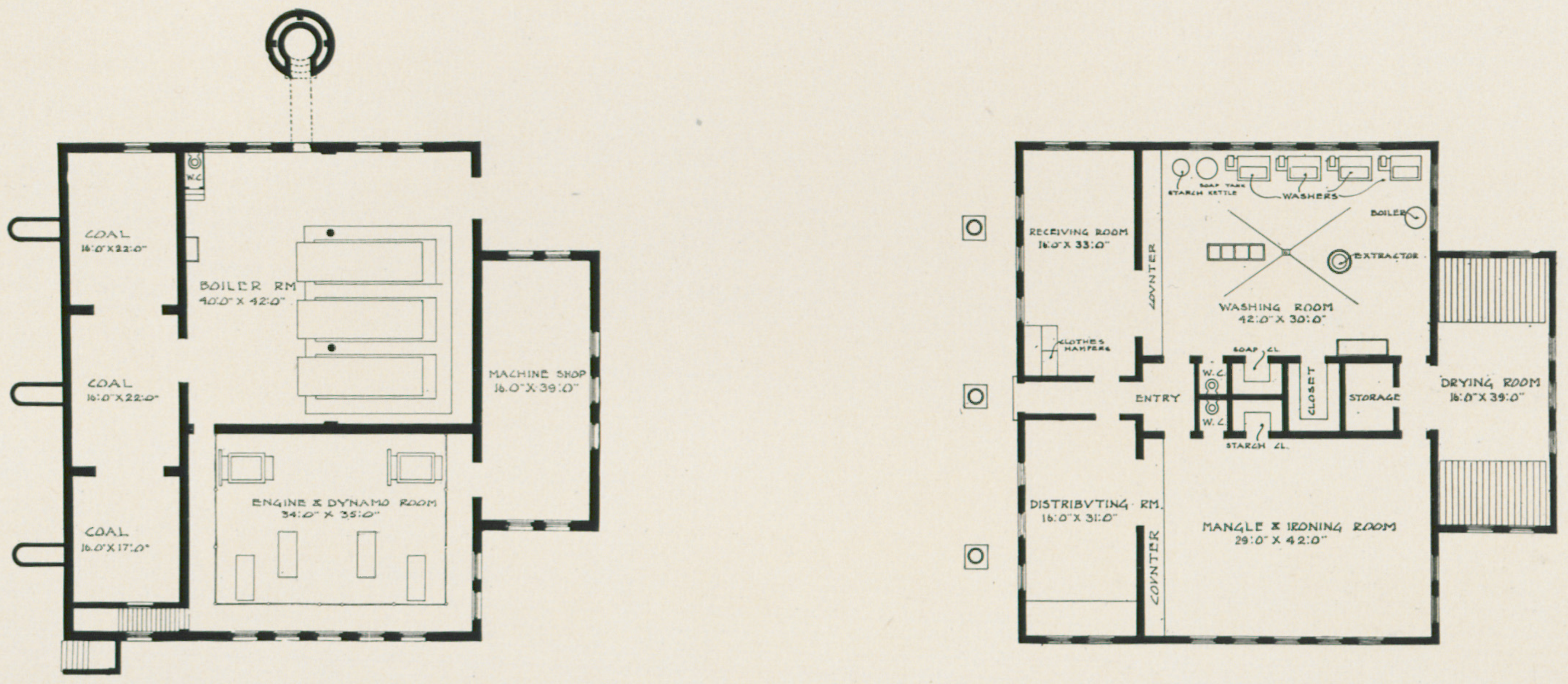
SECOND FLOOR PLAN.



FIRST FLOOR PLAN.

Boston Lunatic Hospital, Austin Farm, Dormitory.

including electric light wiring and plumbing, was $360,000.00. The cost of kitchen furnishings and laundry equipment was $6,800.00. The cost of boiler and heating apparatus was about $61,000.00.

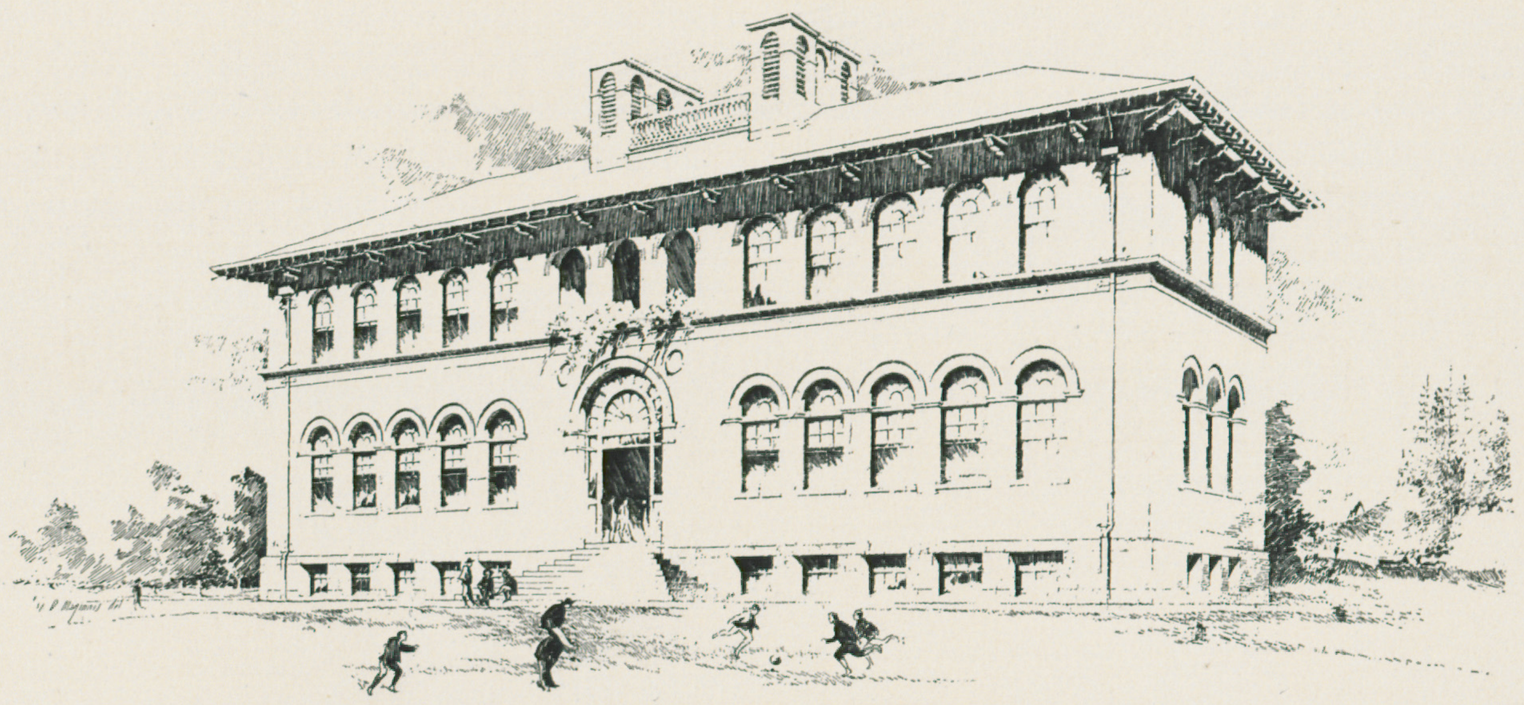


BASEMENT PLAN. FIRST FLOOR PLAN.

Boston Lunatic Hospital, Austin Farm, Boiler House and Laundry.

Parental School for Boys.

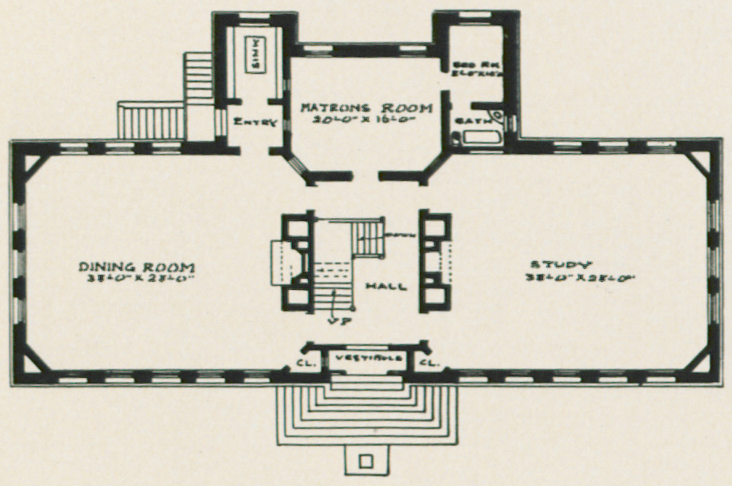
The Parental School for Boys is situated on the banks of the Charles River in Ward 23 (West Roxbury). The buildings built for this school by Mr. Wheelwright are one Dormitory, and a Domestic Building in which there are kitchen, bakery, laundry, and the boiler plant for the whole institution. The Dormitory is placed as one of the group of several such buildings



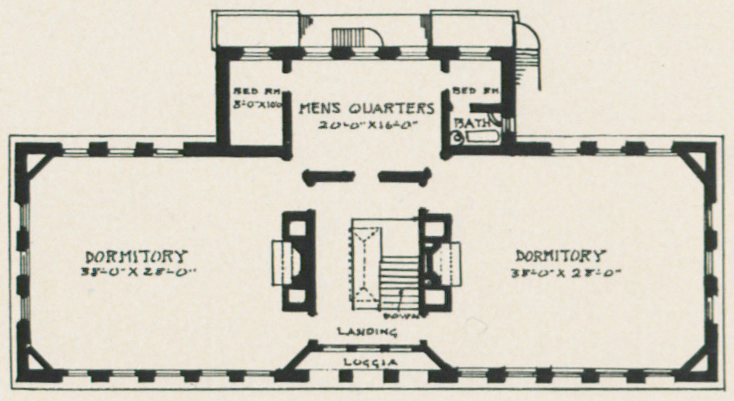
Parental School for Boys, West Roxbury.

to accommodate from thirty to forty truant boys, classified in accordance with their ages. Each group is controlled by a master and a matron, the master overseeing the boys at night, the matron during the day. The matron's rooms are placed so that she can overlook the study and dining room in the first story; and for the master a similar opportunity is given for the supervision of the dormitories. In the basement, which is high and well lighted, are a work room, a locker room, and ample bath and toilet rooms. The School Committee and Commissioners of Public Institutions, who were entrusted by the Legislature with the organization of this institution, sought to provide as much work as possible for the boys by assigning to them the ordinary work of the institution. It was the intention that regular details of the boys should be assigned, and that the duties of the individual boys should be

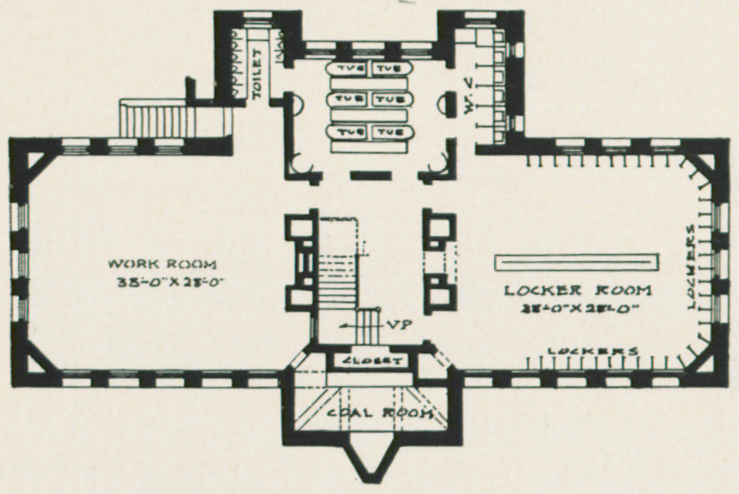
varied from time to time, so that the washing, cooking and serving of food, caring for boilers, etc., should come to each in turn. To that end the central Domestic Building and Boiler House was built, in which cooking and laundry work was to be done by the boys.



FIRST FLOOR PLAN.



SECOND FLOOR PLAN.



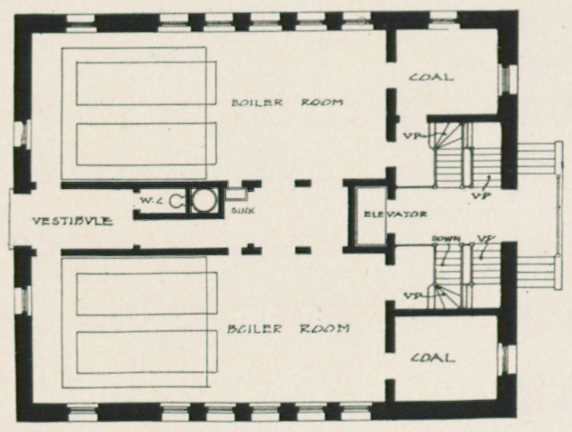
BASEMENT PLAN.

Parental School for Boys, Dormitory.

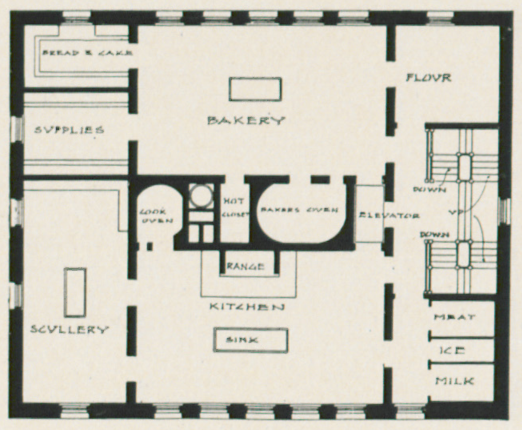
These buildings are built with external walls of water struck brick, with white marble trimmings. The interior walls are unplastered, the brick being painted. The floors are mill construction finished in open woodwork. The floors of the Dormitory in the first and second stories are of Georgia pine, and asphalt is used in the basement. The floors of the Domestic Building are either brick or asphalt.

Cost.

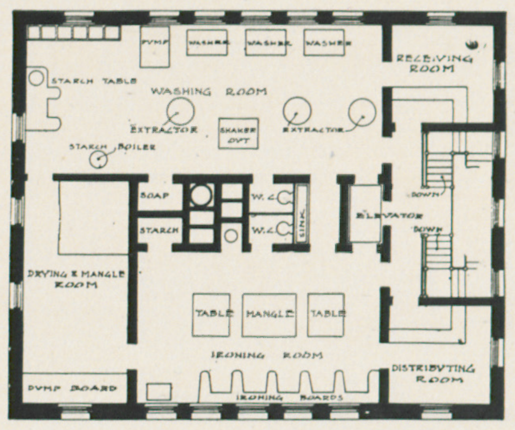
The cost of these two buildings, not including equipment but including heating, was about $80,000.00. The Dormitory is further illustrated by Plates LXIX., LXX. and LXXI.



BASEMENT PLAN.



FIRST FLOOR PLAN.



SECOND FLOOR PLAN.

Parental School for Boys, Domestic Building.

IV.

IN the problems of heating and ventilating, the conditions appear in combinations too nearly infinite in variety for inexperience to cope with. It is for this reason that so many amateurs, especially architects and physicians, who, relying too much upon their general scientific training, have applied their skill to this difficult branch of construction, have become so completely discouraged. When they had once entered the field of this special practice they found themselves in a pathless wilderness with neither guide-boards nor compass. Not until they had taken the first step did they realize that they were dealing with a subject containing a vast amount of unclassified facts and ill-assorted knowledge of various methods, that no true rational basis was established, and that nothing was reduced to a system. Out of this chaos no one can hope to bring order without an enormous expenditure of time and labor. It is true that the chief laws relating to heating and ventilation were long ago investigated and clearly stated; but these laws are the result of a study of each element by itself, freed from the inevitable complications arising in practice where several elements have to be treated at once. For many years, also, the need of artificial ventilation and of the proper maintenance of healthful conditions by a regular supply of fresh air at all seasons has been recognized. The problem of the present day is to design processes and to devise apparatus which shall, operating under fixed and known laws, transfer heat and air from one point to another, the mode of transfer being adapted to the varying conditions found in buildings of various classes, under differing states of wind and temperature. This adaptation is purely a question of engineering. It demands peculiar judgment, skill, and inventive faculty, which are developed only by experience and without which success in dealing with the manifold problems presented can hardly be attained.

The problems of heating and ventilating demand scientific treatment.

It would be tedious to recount all the elements which enter into a problem of heating and ventilating, what elements have to be taken into account and allowed for, what variations must be anticipated, and what effects controlled in an apparatus which shall yield a certain result under a variety of conditions; but it is important and will be instructive to take up one or two of these elements to illustrate the chief difficulties that are to be met with, and to show how they are to be overcome. But few people demand a supply of fresh air as well as a comfortable temperature in a room; and still fewer are willing to bear the expense of introducing fresh air. Heating, then, takes first place in the study of the question, because it is regarded as an indispensable necessity; and ventilation, as being subordinate, takes a secondary position. It is, however, evident that both branches of the subject are so related that they must be treated more or less together. Still, notwithstanding their interdependence, the difficulties involved in the question can be best shown by considering heating and ventilating

Heating and ventilating must be considered separately.

separately. In Fig. 1 is apparent the flexibility demanded of any heating apparatus. To maintain a uniform temperature within doors, it is evident that the apparatus must be capable of the greatest range of effects as regards the inclosure as a whole, and also of a considerable range of effects as regards each separate part of the inclosure. Finally, it must be capable of both effects at the same time. No system of heating, whether by furnace, steam, or hot water, combines in itself these different kinds of flexibility. The heating effect must everywhere be locally controllable, and this in any mode of heating involves difficulties. In Fig. 2 is apparent the need of some method of securing regularity in the movement of air. Both wind and temperature promote ventilation, but they are uncertain and irregular, and often so join their forces as to produce an undesirable and wasteful excess of movement. The diagram exhibits what is mistakenly called the "natural system of ventilation." A little thoughtful consideration of the conditions to which it is subject will make clear this law. Ventilation is most abundant and even excessive in the coldest windy weather, when heating is most difficult and costly. Conversely, ventilation is least and even deficient on mild calm days, when heating is easiest and cheapest. Subjection to such a law is enough to condemn any system, and it is not necessary to enlarge further upon the other practical difficulties presented by these two problems; they are sufficiently manifest upon inspection of the diagrams. It will be inferred without the aid of emphatic statement that the difficulties which grow out of combining the two have been generally insurmountable. These very difficulties would account for the fact that in practice the desired results are rarely obtained except where the very best judgment in the design is supplemented by conscientious care in the management of the complete apparatus.

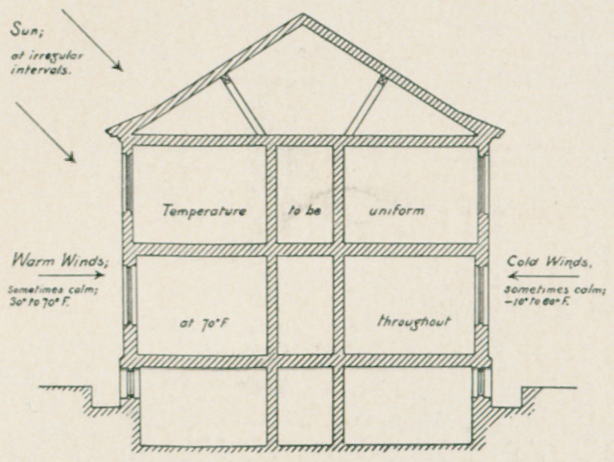


FIGURE 1.

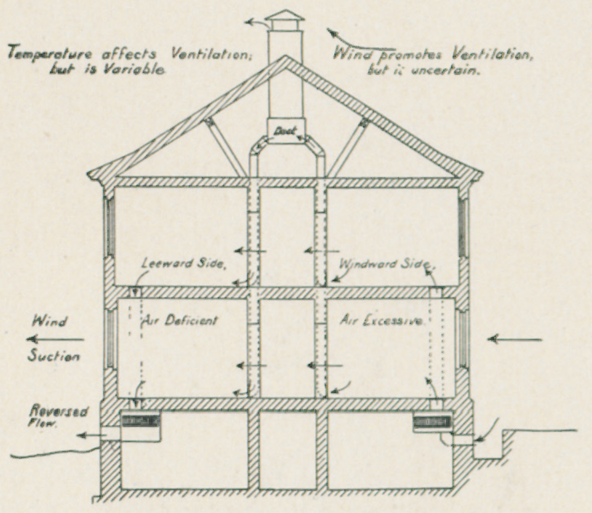


FIGURE 2.

Different systems of heating.

Considering first the subject of heating, it is evident that, since the weather changes constantly and the temperature varies from hour to hour, any system used, whether furnace, hot water, or steam, should embody some means of adjusting the heat yielded by the artificial source to the temporary need. When the system installed is of some magnitude, no simple and inexpensive device has as yet been discovered which affords an effective local control,—that is, a means of adjusting the heat supply of each apartment separately to the actual need for the time being. Although the furnace and hot water systems offer a tolerably good general control, the local regulation is difficult and uncertain. As to low pressure steam heating, it has a limited flexibility and yields only the extremes, the maximum or nothing. Steam radiators must have their valves wide open or tightly closed; they cannot be left partly open, at least not in the systems in ordinary use. But unless absolute control both generally and locally is offered by a heating system, it cannot be held to be perfectly practical and useful. Without some means for the regulation of temperature, therefore, steam heating is not a suitable system. It has held its position, however, because of certain other important practical advantages; and, with the problem of the regulation of temperature solved, it is hardly likely to be superseded by hot water or any other heating system. Indeed, it may be set down as an axiom that direct steam heating is a necessity in any building where large volumes of heated fresh air are required, by whatever means this fresh air may be furnished.

Methods of regulating heat.

The question of methods by which heat may be regulated is one to which architects, engineers, and even experts have given little attention. Hardly any satisfactory appliance for

the purpose had been invented before my introduction of a radiator with an air- and heat-tight jacket and mixing valve in 1876. This is shown with the mixing valve in Figs. 3 and 4. The increased cost of a heating plant installed on this system has unfortunately been fatal to its adoption in America. A system closely resembling it, called Bechem and Post's system, has within recent years appeared in Germany. Four other systems, in which the heat is regulated by means of gauged valves, have also been devised by me; but in each case the additional cost

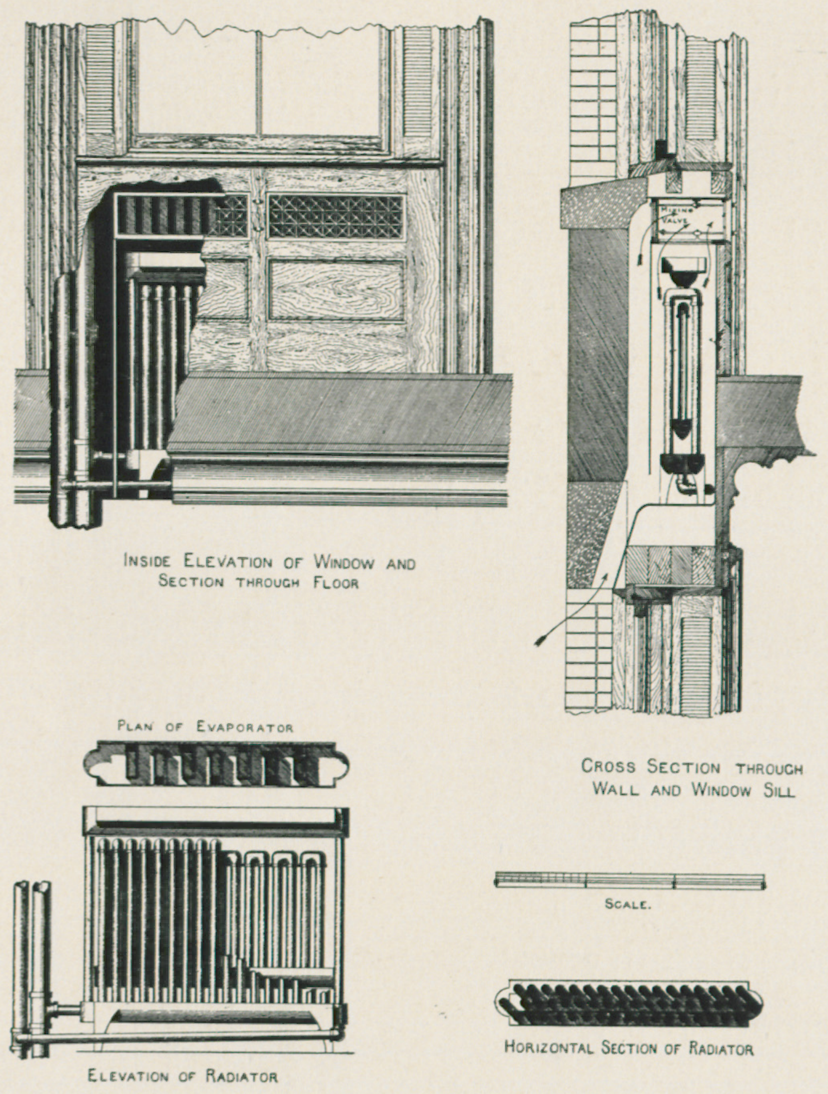


FIGURE 3.

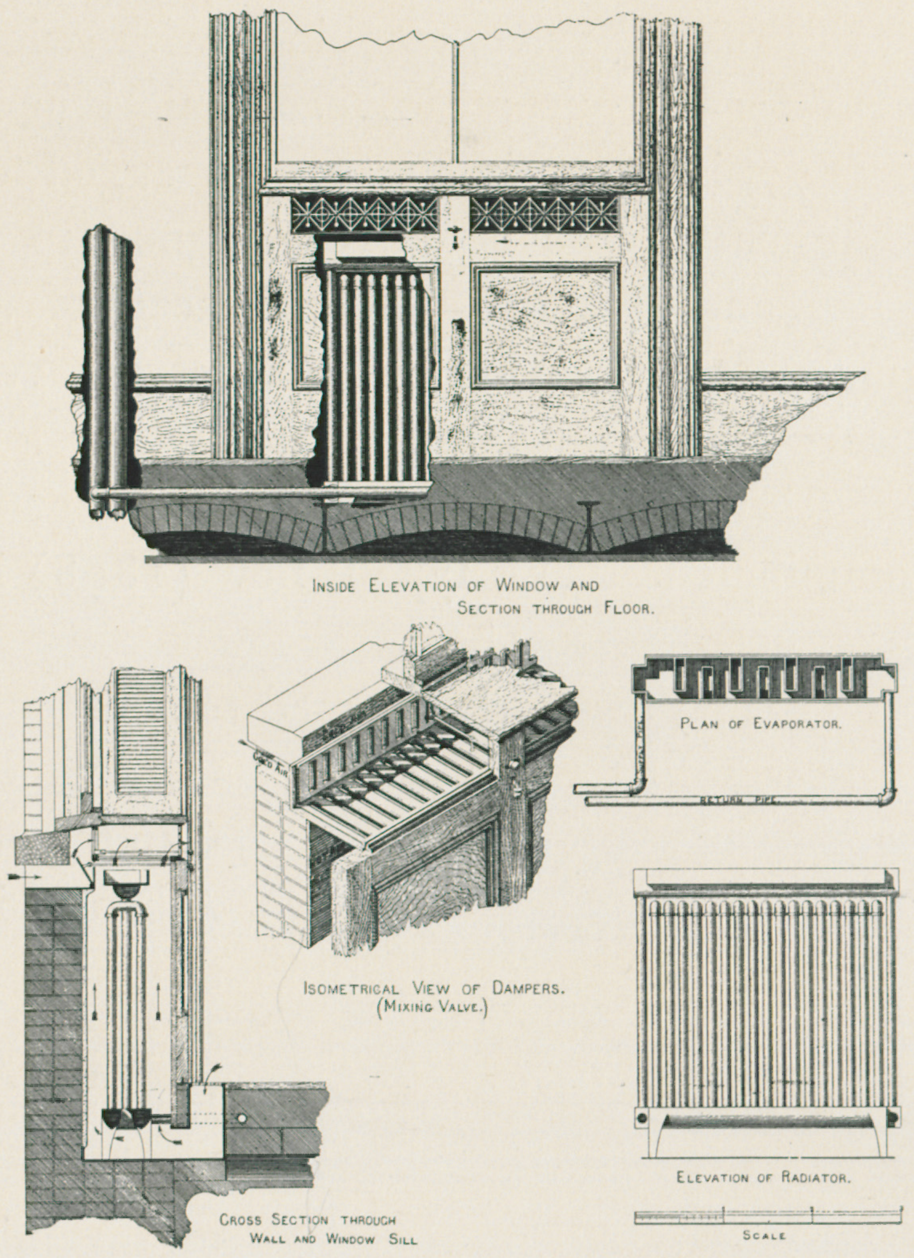


FIGURE 4.

of heating work has been so great that they have been but little used, except that on the continent of Europe the systems have met with considerable favor. It is safe to predict, however, that both a jacketed or screened system and a graduated or gauged valve system will yet find extensive adoption, and that this will come eventually with the gradual appreciation of the objections to steam heating as at present controlled, and with the general tendency to the improvement of methods. As to automatic methods of regulation, they are complicated and expensive, especially for local control, and do not satisfy the requirements for a simple apparatus which will not get out of order. In general the most satisfactory regulation may be secured by the employment of a mixing valve, a contrivance which has become an essential adjunct of good air-heating systems. The mixing valve is spoken of by nearly all writers on the history of ventilation. General Morin was probably the first to point out its value, but no other writer up to 1893 either fully appreciated or emphatically dwelt upon its essential importance. In its early forms this valve was a sort of switch or by-pass (see Fig. 5), usually requiring the adjustment of several movable parts. Thus in Reid's arrangement there are six separate openings to be controlled; in Boehm's, two parts are to be moved in each subdivision of apparatus, and there are many such subdivisions, each of which has to be frequently adjusted. Folsom's arrangement of a switch or by-pass, not fully controlling the heat, had disappeared for many years, when in 1885 it was revived and brought to use in the Cambridge Hospital. The deficiencies of these earlier forms must have been marked, because, although true mixing valves were in use at the Boston City Hospital previous to 1875, yet when the heating system

The mixing valve.

was renewed they were not restored, except in the form of Folsom's switch valve. No other type had been brought forward or introduced subsequent to these early forms; and it is evident that during this period no firm engaged in the business of installing heating apparatus either used or advocated any such contrivance, because there is no instance of its use anywhere. The simple form (see Fig. 5) reintroduced by me in 1876 is, despite its practical disappearance from use previous to that time, the type which has come into general use; and its value is being better appreciated as familiarity with its advantages increases. A more complete form of this mixing valve, combined with switch valves for rotating the contained air of the apartment for the purpose of economical heating before the hours of occupancy, patented by me in 1877, is shown in Fig. 6. Arranged for local heating it is shown in Fig. 4. In Figs. 3 and 4 is shown a type of valve designed to overcome the objection that is made to all mixing valves and switches,—that instead of a stream of air at a constant temperature resulting from a homogeneous mixture of the two differently heated currents, there is likely to be a succession of puffs of alternately hot and cold air. With this valve each current is divided into streams which intersect each other at right angles, and thus the two currents are thoroughly commingled. This type is now (1898) in use at the Boston City Hospital in the buildings constructed since 1892.

Early examples of the combination of fan and mixing valve.

It may be fairly claimed that the application of the device shown in Fig. 5, by which its value was first established and from which its present general adoption has spread, was at the Capitol of the State of New York at Albany, in 1878. This apparatus followed soon after the construction of the apparatus for the Boston City Hall, which will be described later. In the system were combined the use of the mixing valve, the mechanical propulsion of the air, and the use of the fan as a mixer,—the last being a novel and essential feature. It was immediately adopted in New York for the Union League Club House, Anthon Hall of Columbia College, the original Metropolitan Opera House, the New York Cancer Hospital, and many other important buildings. In all these buildings the mixing valve and powerful fans were the chief elements of success, and they were as then used undoubted novelties. Since that time they have become generally adopted, and are now regularly used by all progressive engineers. At the same time with this development came the introduction of the use of exhaust steam for heating, a practice which, in buildings equipped for elevators and fans, effected an enormous economy. This method, employed in the Union League Club House and in another building in New York City, in which steam taken from the boiler used to run the elevators was utilized under a back pressure without any addition or increase of power in the boiler, was a complete novelty in steam heating.

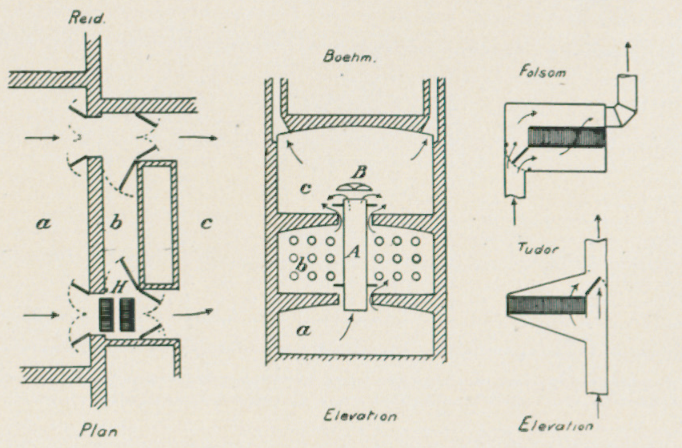


FIGURE 5.

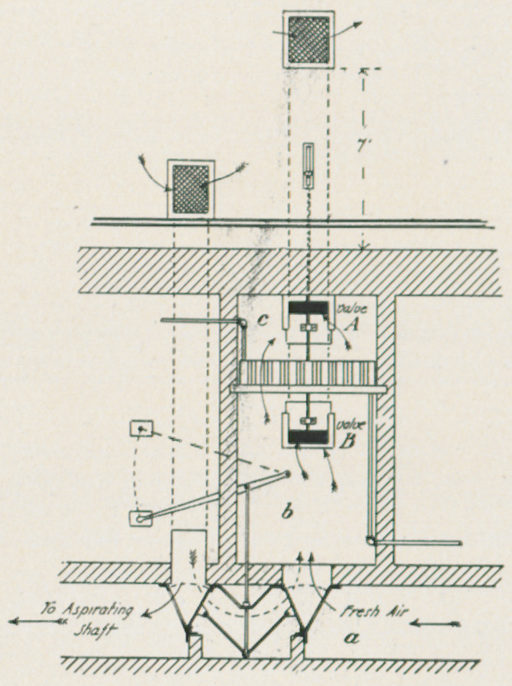


FIGURE 6.

Early history of the plenum fan.

The use of the fan in the combined work of heating and ventilating was practically unknown before 1878. Although the third edition of Péclét's great work, "Traité de la Chaleur," containing his now classical researches upon the transmission of heat, was published in 1861, and Thomas Box's "Practical Treatise on Heat," which is almost wholly compiled from Péclét's work, appeared in 1868, no heating engineer before 1878 used either of these books, except incidentally for reference. Directly or indirectly I have known all the leading engineers in this country from Nason's time to this, and no one of them ever employed in the

studies for his plans any other than empirical and shop rules. There had been, it is true, sporadic attempts to make a practical application of the results of these investigators, and of these attempts the most important was that of Robert Briggs. He was the first to point out the essential utility of the fan, but he was born a generation too soon; he was not listened to. Immediately upon his withdrawal from the field, the engineers of the day not only rejected his advice and opinion regarding fans as a means of ventilation, but never lost a chance to remove or abandon those in existence. Thus some twenty years ago when the Boston City Hospital was refitted, Briggs' fan was left out of the plan and has stood unused from that time. So, too, an excellent fan system in the Boston Custom House was abandoned. No engineer of this period (1875-80) was willing to father any plan which embodied a ventilating fan; and in 1879 a plan including a plenum system with a fan for the English High and Latin School Building in Boston was rejected as being quite unsuitable and entirely inconsistent with the best practice. The influence of Robert Briggs, however, had not been entirely lost; here and there architects demanded fans. For example, a plenum fan was used in the ventilation of the Court House in Providence, in the Danvers Insane Asylum, and long previous to this period in the Massachusetts State House. Still these fans were either not properly applied, or at least so applied as not to secure the practical effect most desired,—namely, complete control of the heating and ventilation without interference with or suspension of either branch of the joint operation. The general opinion of the fan as an impracticable machine prevailed in Europe as well as in America. In England, except in one or two rare cases where eminent engineers had influence, the fan had never been recognized. In France the Opera House was constructed without it; and while the Hôtel Dieu was supplied with one, the design and arrangement were utterly inadequate to the requirements. Thus in 1877 the plenum fan was practically abandoned.

Installation of the fan system in the Boston City Hall, and in the Capitol at Albany.

It was at this time that my own investigations and experiments with the fan began. I soon came to the conclusion that the general failure in its use in ventilating was due to two causes: first, the power required to drive the fan had always been underestimated; second, no adequate means had ever been provided to control temperature. The investigators of the practical requirements had relied too much on the deductions of theory, and had neglected to include in their computations all the different kinds of resistance which, when added together, represent the total work to be done by the fan. I found that the power ordinarily believed by engineers to be sufficient to drive a fan was utterly inadequate, and that to produce a really satisfactory result the mixing valve should be used with the fan. My first experiment was with a working model of a ventilating system. The apparatus consisted of a 6 horse power boiler, an engine, an "Exeter" blower, a heating coil, and a mixing valve. My object was to devise a system of heating by fresh air which should be susceptible of regulation by a mixing valve mingling hot and cold currents of air within and by a blower. This model was inspected by a committee of the City Council of Boston, and as a result it was arranged that the system should be installed to ventilate the Council Chamber in the City Hall. The engine built to run the fan was rated to deliver 5 horse power with the steam pressure available at normal speed. When the apparatus was set up, however, the engine proved to be overloaded. After various attempts it was finally decided to put in a much larger engine. The result was that the stipulated volume of air was at last supplied to the Council Chamber, but with an expenditure of nearly 12 horse power. This experience proved valuable to me when, a few months later, the system for the Capitol at Albany, New York, was devised. For one-half of this building two double inlet blowers, 7 feet in diameter, were arranged. To run these two fans an engine of 125 horse power was installed. At the time this seemed almost absurdly

large; but my recent experience had demonstrated the fact that, even in the computations of Combes and other French engineers, the quantity of power given as necessary to drive a fan was too small; and in this case I was determined to have power enough. The result proved most interesting. In the rush to complete the building, which was opened in January, 1878, it had not been possible to close the window openings and the main entrances, and so keep the building warm. All through the early winter men had been fitting the iron frames for the windows, and it was not till two days before the building was to be inaugurated that the last one was closed. There were neither screens nor glass in many windows, and only a rough barricade of boards where the outer doors were to be. The building was finally closed from the weather only forty-eight hours before the day set for the formal opening. During that time the engine was stopped only for oiling, and, running nearly up to its full capacity, gave the huge blowers four hundred turns a minute. The temperature rose hour by hour until in many rooms the thermometer marked 70°, while ice formed by condensation inside the windows stood 4 inches thick on the lower parts of them. This condensation came from the water held by the solid masonry of walls and floors. On the night of the inauguration, although the temperature outside was 12°, the building was everywhere perfectly warmed; and in addition a large tent placed in the courtyard to serve as a supper room and joined to the building by a canvas passageway was kept comfortably warm by the same apparatus. The cost of the heating and ventilating apparatus for the building, although at first placed at $240,000.00, was actually only $110,000.00. Later on a complete system of electric lighting was installed, the engines, thanks wholly to the utilization of exhaust steam, being driven by the same boilers that supplied the power for the heating.

Three principles on which the fan system is based.

The remarkable success of this installation established three new principles: first, the efficiency of the heating coils is increased by the fan about three times; second, the power which is taken to drive the fans does not cost anything if the exhaust steam is used for heating; third, ventilation is made practical and placed perfectly in control by a central system imparting both heat and movement, if supplemented by local heaters proportioned to the exposure. The first two of these principles are merely economical. Nevertheless they remove many of the objections to the fan system, since, in the first place, the cost of the installation is not increased by the fan and engine, this being balanced by the saving in the quantity and cost of the air-heating apparatus, the reduced size of ducts, etc.; and since, in the second place, the cost of the power is nothing by this system, the exhaust steam being worth just as much for heating purposes as it is before it enters the engine. The last of the three new principles is practical and relates only to the control of temperature and of air volume. Subsequent applications of this system involving these principles required only an adaptation of details. The general practical form can be shown in a single diagram (see Fig. 7). It should

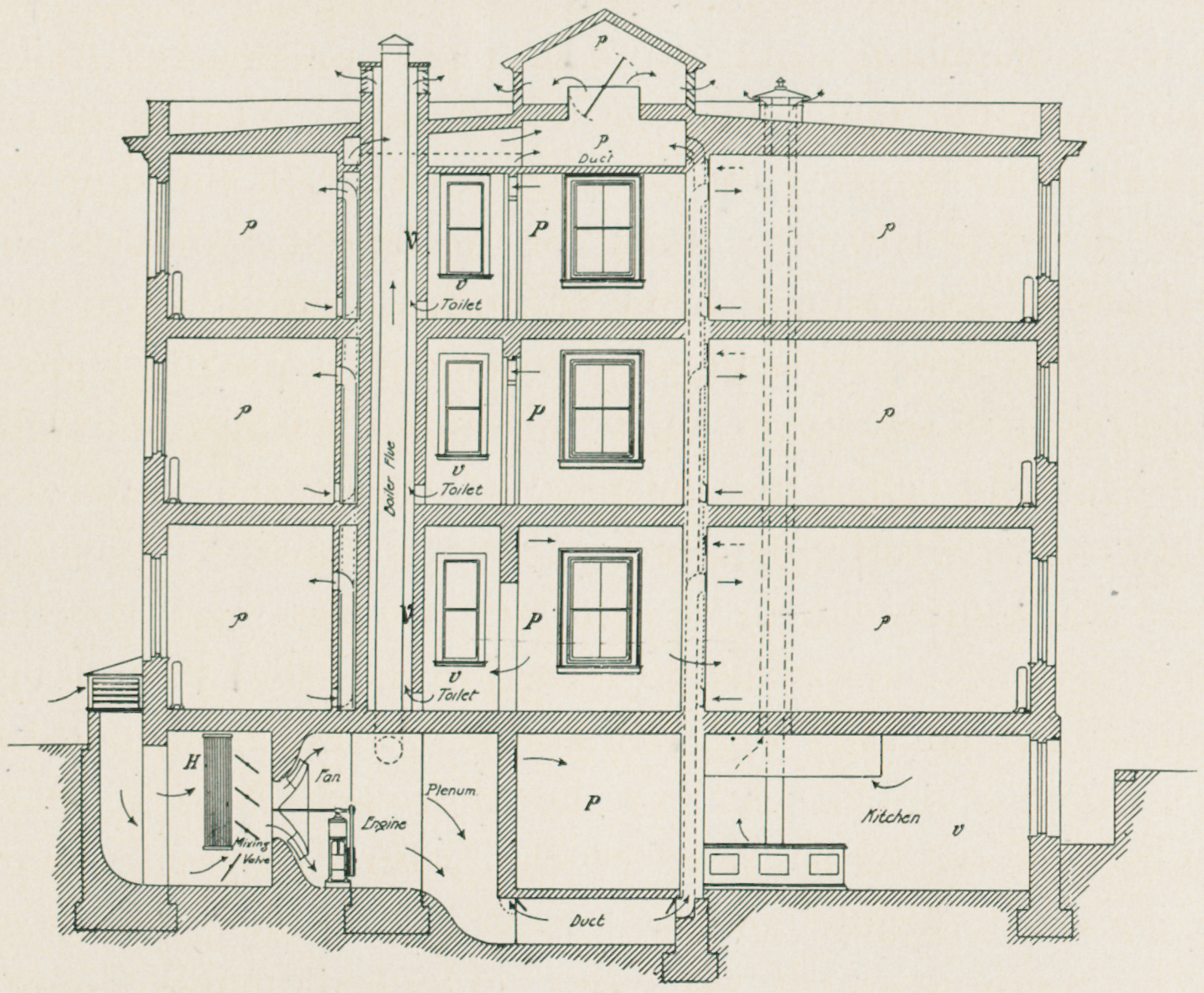


FIGURE 7.

be understood, however, that in connection with the system as here shown a separate system of heating is to be installed which shall reach every part of the building to be warmed, and which shall have no relation whatever to the system of ventilation. As a rule, the heaters are to be placed where they will do the most good, and where they will be least in the way, preferably under the windows, and provided with screens or not, as the case may be. When it is imperative that the local heaters be placed in the cellar, they should be so arranged with flues as to heat the contained air of the inclosure by rotation, as in Fig. 6 with the lower switch thrown, the air going down one flue to the heater where it is warmed, and up another to the room whence it came. In a hospital, the point of discharge is preferably through the window stool vertically. Details of the application of this method will be found on page 33 in the description of the new wards of the Boston City Hospital. In other cases it is desirable to place the local heaters in the cellar and to use them as supplementary heaters to raise the temperature of the ventilation air from its normal point as fixed by this system (70°) to the point necessary to supply the loss of heat through walls and window glass. This method complicates the apparatus, since it makes separate mixing valves like those of Fig. 6, A and B, indispensable for each flue. With a heating system thus installed, each room having a local heater proportioned to the extent of its exposure and relative loss of heat through cooling walls and window glass, it is possible to manage the heating without reference to anything else. The heaters may be turned on or shut off at the convenience of the occupants of a room, but in no case can this action suspend or interfere with the system of ventilation, which, in effect, is a separate installation.

Ducts and flues used to convey heated air for the purpose of ventilation.

In the discussion of the means and methods by which ventilation is secured, it should not be forgotten that ventilation is, as has already been stated, a separate process. In the first place, it is well understood that in northern climates fresh air must not be introduced into inhabited places in winter without being first warmed. The standard temperature of 70° is too warm for some persons, but in the dry atmosphere of America it probably causes no real discomfort. Air supplied to every room at 70°, however, is not warm enough to keep the temperature of the room at that point while the continuous loss of heat goes on through walls and window glass; if it were, a separate heating system would be superfluous. As it is, those who prefer a lower temperature may obtain it by shutting off the local heater. In the supplying of this warmed fresh air there is no practical difficulty, even for the largest buildings, in heating all the air at one or two central points, and in conveying it by ducts and flues to the rooms without loss of heat on the way. The temperature of most basements is usually higher than 70°, because there are unavoidable losses from steam pipes and boiler settings; but all appreciable loss may be prevented even in cold cellars by constructing the ducts of porous plaster blocks on metal frames. The ducts are finally plastered, and when finished the sides are about 2½ inches thick. Thus, even when surrounded by cold air, they lose heat slowly. Metal ducts, however, lose heat rapidly. If the ducts must go underground, they should be made of hard brick laid in cement, and should be lined with one course of very light, porous bricks laid in lime mortar. The cheapest kind of bricks, which are not thoroughly burned, may be used, as they are good non-conductors. If the return pipes of the heating system are laid in the underground duct, they will be always accessible, and will make up by their presence for any loss of heat into the earth. The temperature of the earth under buildings is almost constant at 59°, a point not low enough to affect the temperature of the moderately warm air in a well-built duct.

Three principles of ventilation.

In order to insure satisfactory ventilation three principles must be observed: first, each inclosure should have its proper share of fresh air; second, from each inclosure should be

removed an equivalent of partly exhausted air; third, any movement of vitiated air which is not directly outward should be prevented. The first of these requirements is satisfied by sufficient power in the fan, ample capacity in the ducts and flues, and a regulating damper applied to each flue and adjusted by trial. The second requirement demands outlet flues having a capacity equivalent to the inlets, each outlet flue being arranged to have a discharge, which may be equalized with other outlet flues by means of regulating dampers, into a main duct. This main duct should lead to the roof and should be closed when the ventilation is suspended, as may be the case when the building is merely to be kept warm. The third requirement demands that the whole building should be subjected to a plenum, that is, a pressure in excess of the external pressure of the atmosphere; that the corridors should be provided with a supply but no exhaust of air; and that certain spaces from which it is most important that there should be no reverse currents of air should be subjected to a vacuum. The first two of these principles are self explanatory. As to the third, its importance merits a little attention. Its effect is to prevent air from moving across corridors from room to room. If there is a plenum in the building and no outlet for air sent to the corridors, its only escape is by overflow into the rooms. Thus any exchange of air from one room to another is prevented. It will be seen that this plenum prevents the escape of air into the building from undesirable sources, and also prevents draughts of cold air from windows and outer doors, a most important result in theatres and large halls. It is further requisite, as a part of this system, to isolate atmospherically all inclosures which may be the sources of odors or of any kind of bad air, dust, vapor, smoke, or emanations from sink rooms and lavatories. Such inclosures as these are to have outlets only, and the outward movement is assured by connecting them, as is usually convenient, to an aspirating shaft, which may be large enough to contain and give access to all the plumbing pipes. Since these outlets are the most favored ones and since they are not dependent upon the plenum alone, the impelling force is always alive, whether the plenum system is in action or not. Such inclosures are forced to borrow their renewal air from the corridors; and this air, according to the principles of the system, has the highest degree of plenum, and necessarily seeks relief in the direction of the least resistance. This direction is made positive by the aspirating shaft, as already explained and clearly apparent in the diagram (Fig. 7). The prevailing pressures of air are indicated by letters, P. signifying maximum plenum; V. maximum vacuum; p. moderate plenum; v. moderate vacuum.

Summary of the advantages of the fan and plenum system.

Finally, the advantages of the system may be summed up as follows:—

1. The heat is applied at those points where the loss of heat takes place, and is applied in proportion to the loss, and in the form favorable to the greatest economy.

2. The heating is effected without any loss to the warm air contained in the building. Air is not taken in at a temperature below zero and thrown away at above 60° after it has been used to transfer heat to the rooms,—a wasteful condition commonly found when the fan system alone or the indirect system is used. This advantage has a material bearing upon the economy of heating in the case of buildings designed for temporary occupation, such as schoolhouses, which are occupied only twenty-five hours a week.

3. Any slight irregularities of heating, causing higher or lower temperature in rooms, are quite neutralized by the effect of the continuous supply of air at 70° which, acting as a sort of balance wheel, tends to bring the room to the standard of temperature.

4. In case of the temporary disablement of the machinery of engine and fan, the building may be kept warm and in a condition fit to occupy, being certainly in no worse condition than that of ordinary unventilated buildings. This kind of interruption, however, is rare, and by the provision of a duplicate engine it may be made impossible.

5. The ventilation is put under control. It is independent of wind and outside temperature, neither of which is to be relied on to promote ventilation. Air is supplied only when it is wanted and in appropriate, even exact quantities. Its temperature being uniformly 70°, the standard for occupied rooms, there can be no need and no excuse for shutting it off or interfering with it in any way, while those who prefer a lower temperature have only to shut off the local heaters. Further, when the air supply is increased or diminished according to the number of occupants of a room, the heating is not disturbed.

6. The ventilating in cold weather may be cut down to the barest needs, thus economizing fuel; and in mild weather, when little fuel is required for heating, the rooms may be flooded with pure air. The value of this feature deserves a wider appreciation than it has yet received. It has already been shown that natural and aspirating systems are so affected by wind and temperature that the greatest ventilating effect is produced in the coldest weather when heating the air is most costly. Another fact, far from being as generally understood as it should be, is that aspirating shafts are so expensive to operate in mild weather that they are allowed to fall far behind their calculated work, and, when ventilation can be best afforded, they stand almost inactive. The fan costs nothing to operate whenever heat is required, since the waste steam by which it is run, and with it substantially the total original heat taken from the fuel by means of the boilers, is utilized in the heating apparatus. Even if the exhaust steam be thrown away, the cost of the fuel to generate it is less than one-sixteenth that of the best aspirating shaft; and the area of all the ducts when the fan is used is one-half as large as that demanded by the aspirating system. These possibilities and conditions constitute a complete antithesis to those existing under the natural and the aspirating systems, and fully establish the claim of the fan and plenum or pleno-vacuum system to be not only strictly practical but highly economical.

After this explanation of the principles of the fan and plenum system, the reader is better prepared to understand the following detailed description of the heating and ventilating apparatus installed in the hospital buildings constructed by Mr. Wheelwright.

The distributing system for the Boston City Hospital.

THE Boston City Hospital is an immense plant, covering about 20 acres of perfectly level land, and the method employed for circulating steam and returning the condensed water merits some attention. The plant is designed to utilize the exhaust steam from the electric power plant, at a pressure not to exceed 15 pounds. The power house is on a separate lot of land on the opposite side of Albany street. The pipe conduit is level and its bottom is at grade 8, or 4 feet below mean high water. Although it is water tight, it is provided with powerful ejectors to keep it empty of water in case of leak or flood. The pipes are graded

by means of a special leveling instrument on an inclination falling from the boiler house at the rate of 1 in 200. At each manhole is a steam trap to remove condensation. Steam is taken from this main in each building by a low pressure reducing valve, and reduced to about 2 pounds or less, except in very cold weather when 10 or 12 pounds may be carried. The method of collecting the return water so as to avoid noise from the discharge of the steam traps is as follows: The common water line of the return system is fixed by the receiving tank in the boiler house; the water keeps the return pipe full, so that there is no chance for water hammer, and stands at the same level substantially in the upright branches in all the buildings, or between the lines *a* and *b* (see Fig. 8). The branch return is extended up to the roof as a vapor pipe, and relieves the return from steam pressure when the traps discharge under pressure. The trap discharge is entered at a point above the general water line; the steam released by the reduction of pressure to that of the atmosphere escapes by way of the upright extension, while the water falls by gravity and eventually reaches the receiving tank. The local water line is simply fixed to seal all the local branch returns. This apparatus is absolutely noiseless, circulates by gravity alone despite the level grade, and there is little if any loss of heat from vapor. The system includes a high pressure return which receives the trap-water from the high pressure main and the heating main. This return, in order to prevent water hammering and to avoid the effects of pressure, is drained dry. It is on a slight but regular falling grade, and the steam formed by the release of pressure and discharge from the traps is economized by condensation in a feed heater in the boiler house; while the hot water is cooled by running the colder feed water through a coil submerged in it, and is thus fitted to be lifted by the pumps.

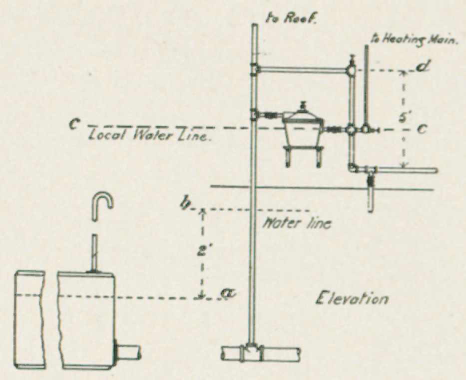


FIGURE 8.

The pipe conduit.

A section of the pipe conduit is shown in Fig. 9. The conduit itself is powerfully ventilated by a motor fan in the engine house, the design being that workmen who have to repair traps, etc., may be kept cool by a current of cold air admitted at the manhole next beyond them, and caused to flow by the aspirating effect of the fan motor. It was first intended to use the annulus of the chimney for this purpose, but the aspirating power was found inadequate. All the pipes are covered, and the hangers are so constructed as to swing to allow for expansion, while for the same purpose the pipes rest on rollers which roll on stirrups in the hangers.

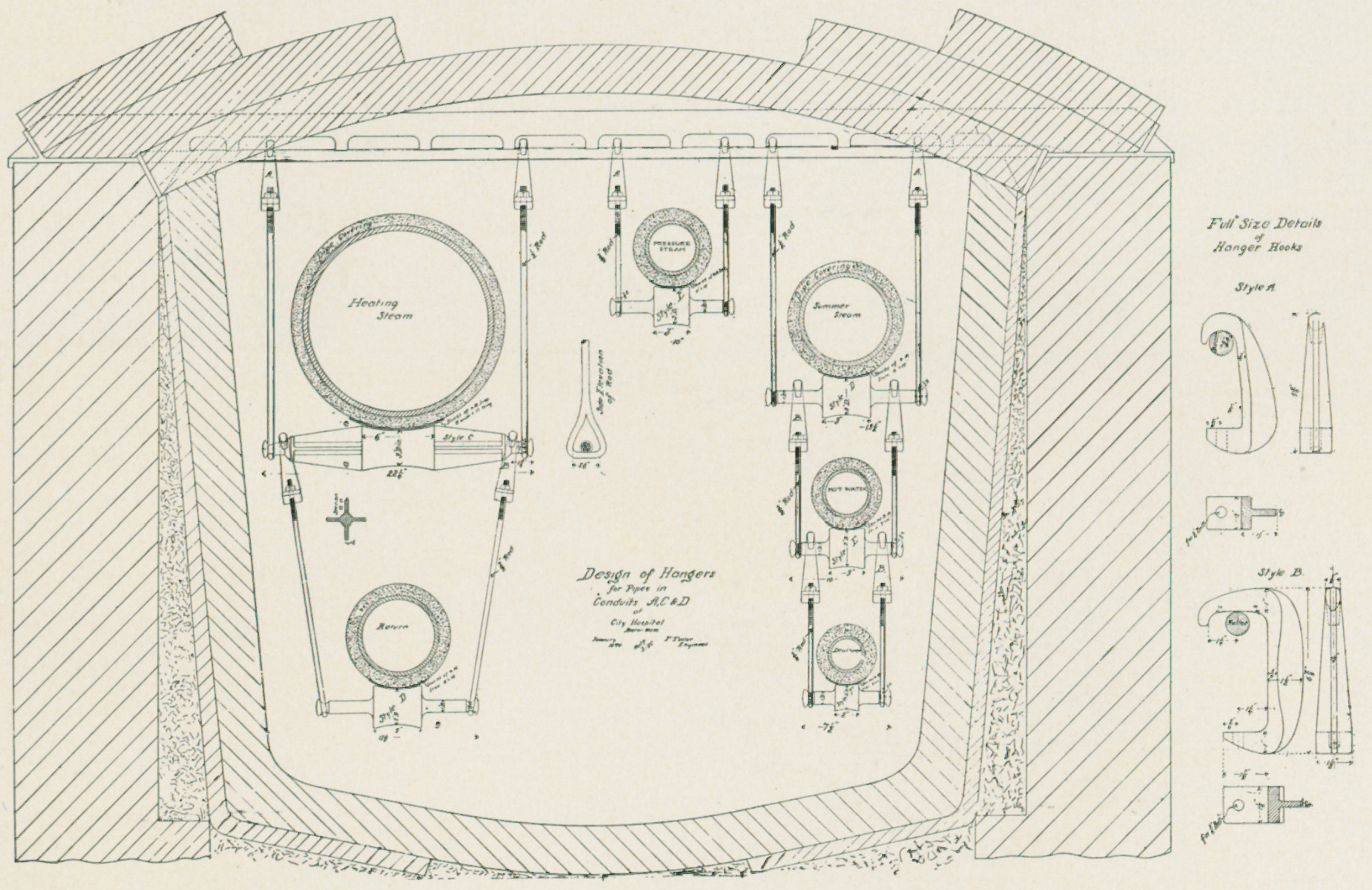


FIGURE 9.

The South Department.

The South Department forms a group of eight buildings adapted to the various requirements of a hospital complete in itself. In these buildings, in accordance with the wishes of the hospital trustees, fans are not used. The ventilating power is obtained from aspirating shafts warmed by steam coils. The inlets for air are in the peripheral walls several feet above

the ground level, and each inlet serves two heating chambers. The characteristic feature of the system is the mixing valve and the mode of admitting air to the wards. The mixing valve, substantially the same as that shown in Figs. 3 and 4, is adapted to heaters placed in the basement, and is operated by a revolving shaft extending up to the window stool. The registers are cast iron boxes the whole width of the window, with the grating for air admission at the top of, and forming a part of, the window stool (see Fig. 10). This has proved to be a very practical arrangement, since there is no register in the way and there are no air currents to be troublesome. As ordinarily placed, registers under the windows prevent the passages between beds from being used as sitting places by convalescents. As previously explained, the chief defects of ventilating systems like this are their irregular action, giving excess of ventilation in cold windy weather, deficient ventilation in mild calm weather, and outward or reversed draught in the inlet ducts caused by high winds. Contrasted with the pleno-vacuum systems, they suggest a comparison between the spiracular breathing of insects and the centralized respiratory apparatus of the higher animals. A similar system was used in the new buildings for the Lunatic Hospital as described in this volume.

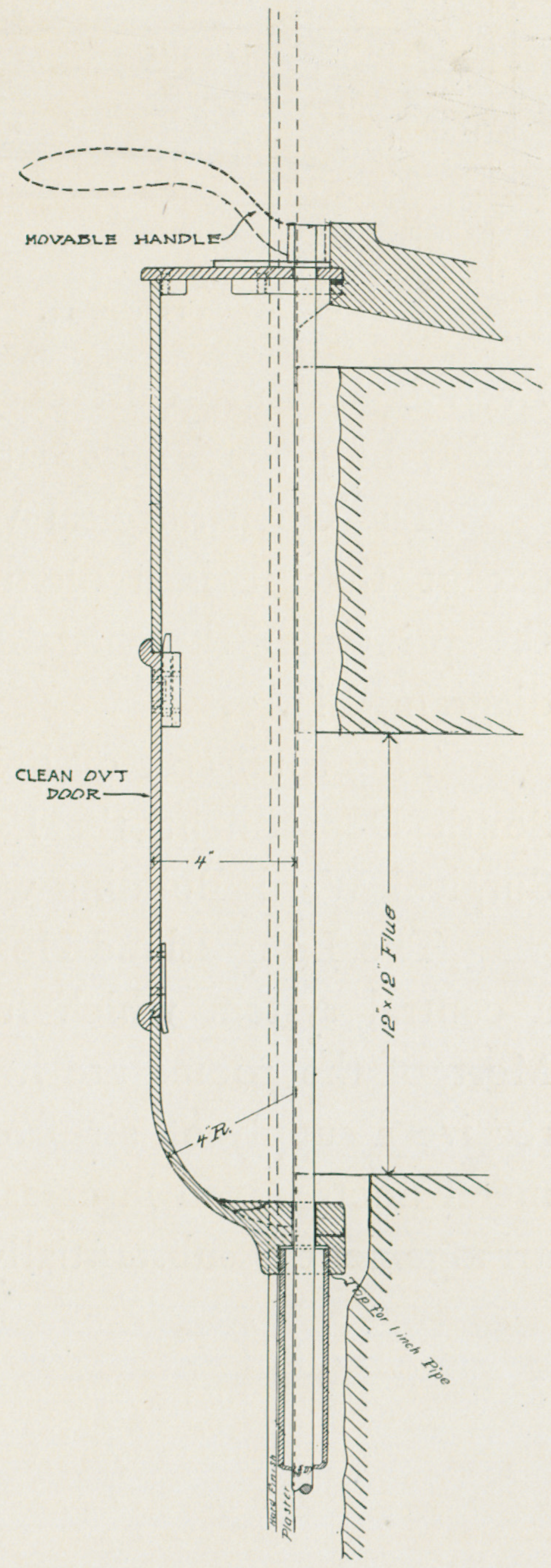


FIGURE 10.

The Pathological Building.

The Pathological Building is supplied with a type of ventilating apparatus that approximates more closely to the theoretical diagram, Fig. 7, than any yet described. The local heaters are under the control of the occupants, yet neither heat inlets nor heaters themselves cause annoyance. The occupants have nothing to do with the management of the ventilation. To provide for effective ventilation at all times for the animal and certain other rooms, there is a powerful aspirating shaft heated by a steam coil at the base. The autopsy theatre is easily kept supplied with perfectly fresh air. An interesting detail of this apparatus is the water radiator. This, although filled with water, is heated by steam, so that the temperature of the heating surface is usually only about 190°. By shifting the position of the draining valve, the radiator may be changed to a steam radiator.

The Surgical Operating Building.

The Surgical Operating Building is an old building, enlarged and reconstructed. The system throughout is modeled upon the pleno-vacuum system of Fig. 7. The direct radiators are screened within cast iron boxes, and the heat is controlled by hinged covers within the screen, which, when closed, are made air-tight by sand joints. The system as to this detail is like Fig. 3, but the register is more nearly perfect by being made air-tight. This feature gives an effective control of temperature. In the operating theatre an attempt is made to filter the air somewhat carefully. There is a primary filter which clears larger particles of dust from the fresh air before it reaches the central heater and fan. The air for the theatre is taken from the general supply, and is treated by a supplementary apparatus for the use of the theatre. This comprises a fan to overcome the resistance of the secondary filter, also a heater and mixing valve to warm the air sufficiently above the standard to allow for heat loss through walls and skylight. The primary filter consists of tubes of cotton sheeting about 25 feet long, and 22 inches in diameter, being made of cloth 2 yards wide, closed at one end, hung on wires, and secured to galvanized iron mouths in the wall of the fresh air chamber (see Fig. 11). This form

of filter, the most compact and convenient known, was first used in Trinity Church, Boston, in 1876. It offers great advantages besides its compactness, in that it may be readily removed and cleansed by being turned inside out, shaken, and then washed in a common power washer. The amount of dirt collected by this expedient is large, but the apparatus cannot reach the point of absolute exclusion of dust, since the cotton would have to be so tightly packed that the motive power to force the air through the filter would be excessively increased. Even if absolute dust exclusion seems impracticable, the advantage of such exclusion as can readily be given is so great that it is well worth striving for.

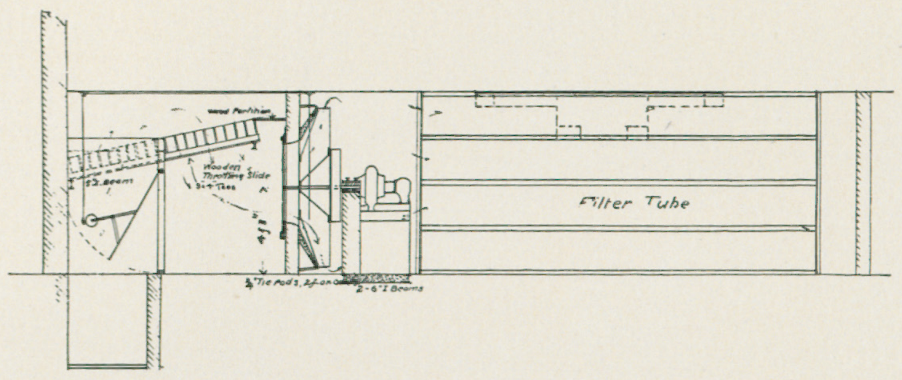


FIGURE 11.

The Open Surgical Ward Building.

The Open Surgical Ward Building has an apparatus like that of the contagious wards, except that it is a plenum system with fan and air-filter, and is designed closely upon the principles sketched in the former part of this article and illustrated by the general diagram, Fig. 7.

The total cost of boilers and the heating and ventilating apparatus for the buildings of South Department, the Pathological Building, the Surgical Operating Building, and the Open Surgical Ward Building was $118,500.00.

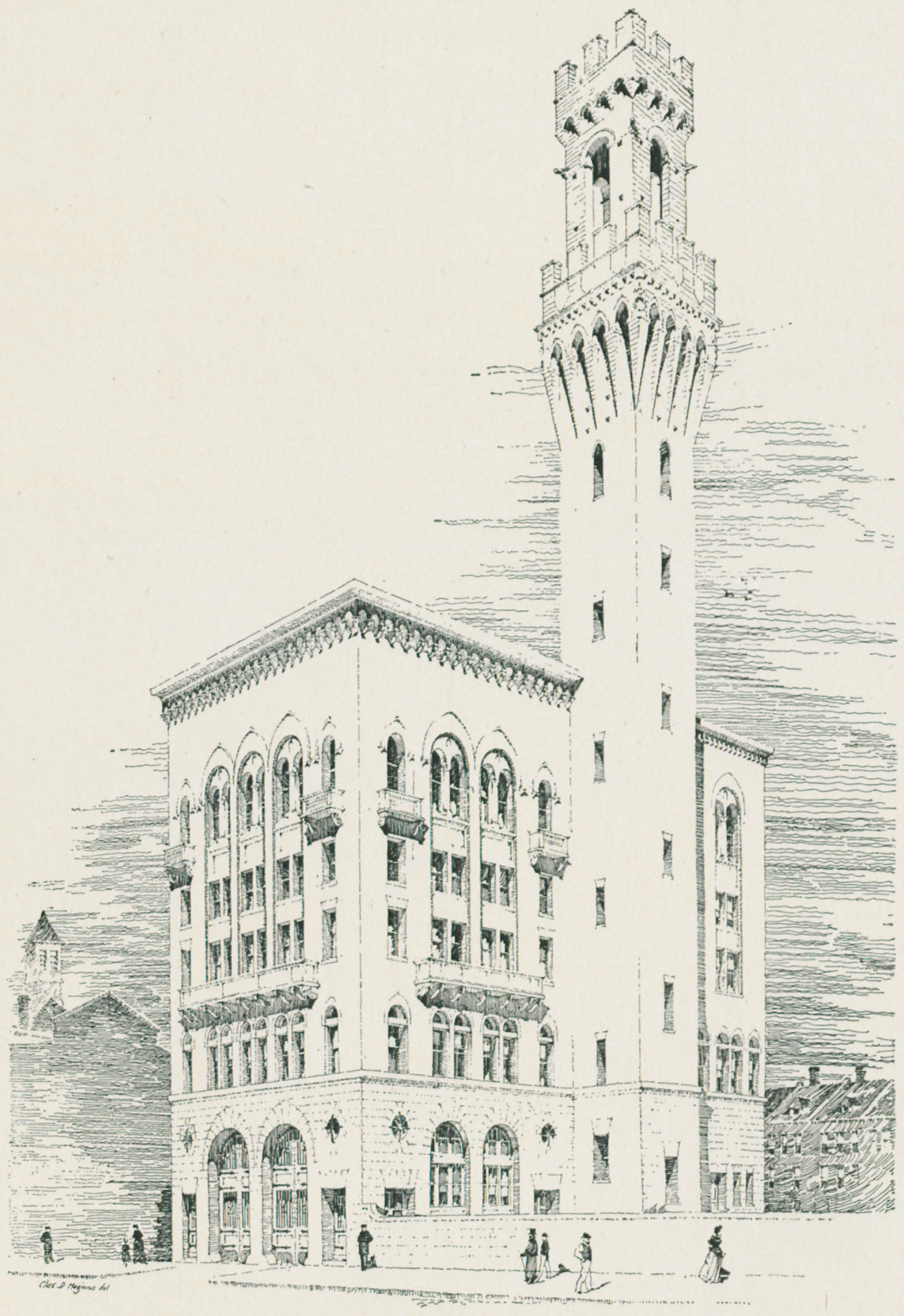
The Long Island Hospital.

The Long Island Hospital has a detached heating and ventilating apparatus operated from a central system which furnishes steam for heating and electricity for power and lighting. Most of the rooms are heated by direct radiation in proportion to their exposure, while all receive a supply of air from a central blowing apparatus. The supply is brought by way of metal ducts boxed in cases made of 2 inch planks and filled with mineral wool. The general arrangement is substantially that of Fig. 7.

V.

THE FIRE DEPARTMENT HEADQUARTERS is situated on Bristol street, Ward 9. The building has four full stories, with two mezzanine floors. The first floor contains the apparatus room, the stable, and the harness room. The stable has accommodation for thirteen horses. Five of these stalls are used for horses in active service, and are connected with the apparatus room in front by spring doors worked by electric trip wires. The upper part of the stable is on the mezzanine floor, the main part of the first story being 18 feet 6 inches high. The stall posts run to girders in the ceiling, and serve for supports for that portion of the mezzanine floor. There is a glazed partition between the apparatus room and the stable. Above the stalls are balconies overlooking the large room below. On the mezzanine floor on one side is a hay loft, and on the other side is a dormitory with bath room, etc. The main entrance to the upper stories is at the left of the apparatus room, and gives into the main staircase hall. At the rear of the hall is the elevator well. On the second floor are the offices of the department. These include the large clerks' room, the Chief's office, and the Fire Commissioners' rooms. To the right of the clerks' room are a small room for reports, the wardrobes, lavatories, and water closets. The third floor contains the gymnasium, with shower baths, etc., and instructor's office. Raised 6½ feet above the floor of the gymnasium is a running track, opening from which are storage rooms. On this mezzanine floor is the room for the inspector of wires. A dormitory for the fire-alarm clerks is entered from the tower. The fourth floor contains the fire-alarm signal station for the entire city. Connecting with the main room at the front is the superintendent's office. In the rear are the dynamo room, where are located electric generators, and rooms for the inspector of wires.

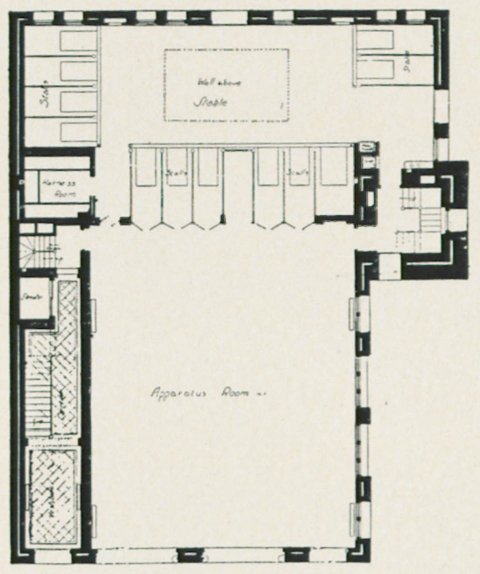
Fire Department Headquarters.



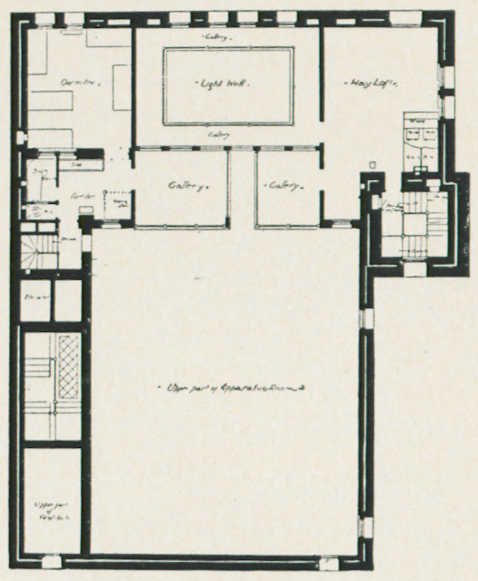
FIRE DEPARTMENT HEADQUARTERS.

Main features of construction.

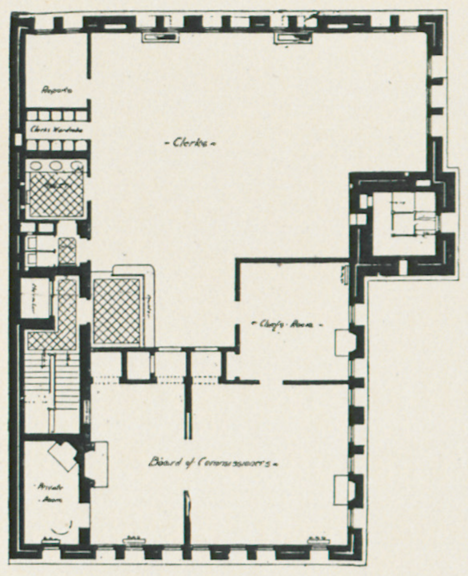
The building is on piles with block granite foundations. The concrete of the basement floor is 12 inches thick, and is finished with 1 inch of asphalt carried up 2 feet on the walls back of the 4 inch brick lining. The exterior is faced with buff New Jersey terra cotta brick, laid Flemish bond in lime mortar. The trimmings are of buff terra cotta and Amherst stone. Marble shields and panels of Bois d'Orient, Brescia, and Red of Levanto marble are used to



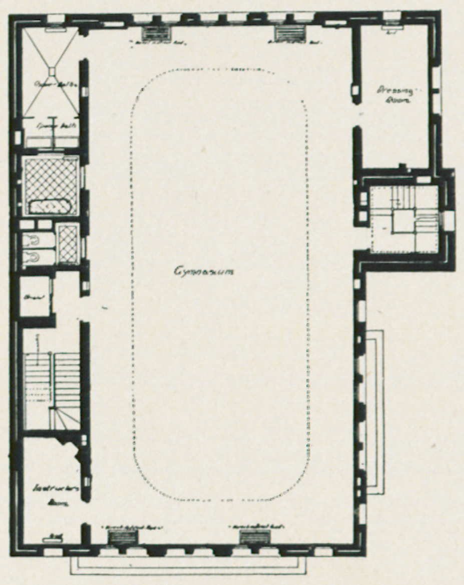
FIRST FLOOR PLAN.



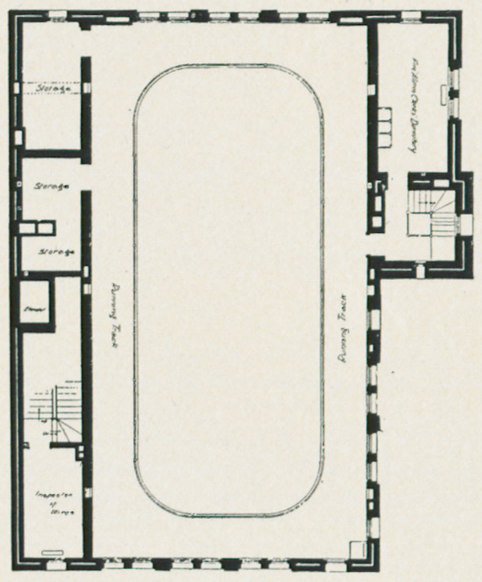
FIRST MEZZANINE FLOOR PLAN.



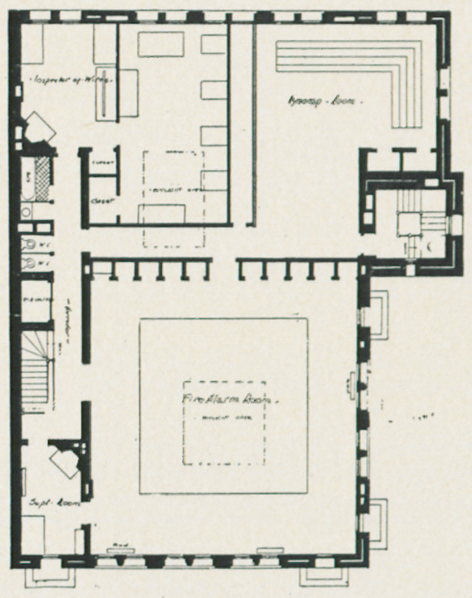
SECOND FLOOR PLAN.



THIRD FLOOR PLAN.



THIRD MEZZANINE FLOOR PLAN.



FOURTH FLOOR PLAN.

give color accent to the design. The floors and the roof are of steel and terra cotta arch construction. Partitions are of terra cotta lumber. Under floors are of spruce, upper floors are of matched and blind nailed rift Georgia pine. On the terra cotta arch construction of the roof is laid 1 inch of Portland cement, covered with five-ply tarred paper. On top of this are slate tiles, laid in waterproof cement. The flashings and the skylights are of copper. The staircases are of iron throughout, with paneled iron risers and scored treads, except that the main stairs have marble risers and marble treads. The main stairway hall to the top of the building has a base of Knoxville marble and a dado 5 feet high of white enameled tile. Above this dado the walls are lined with buff terra cotta brick.

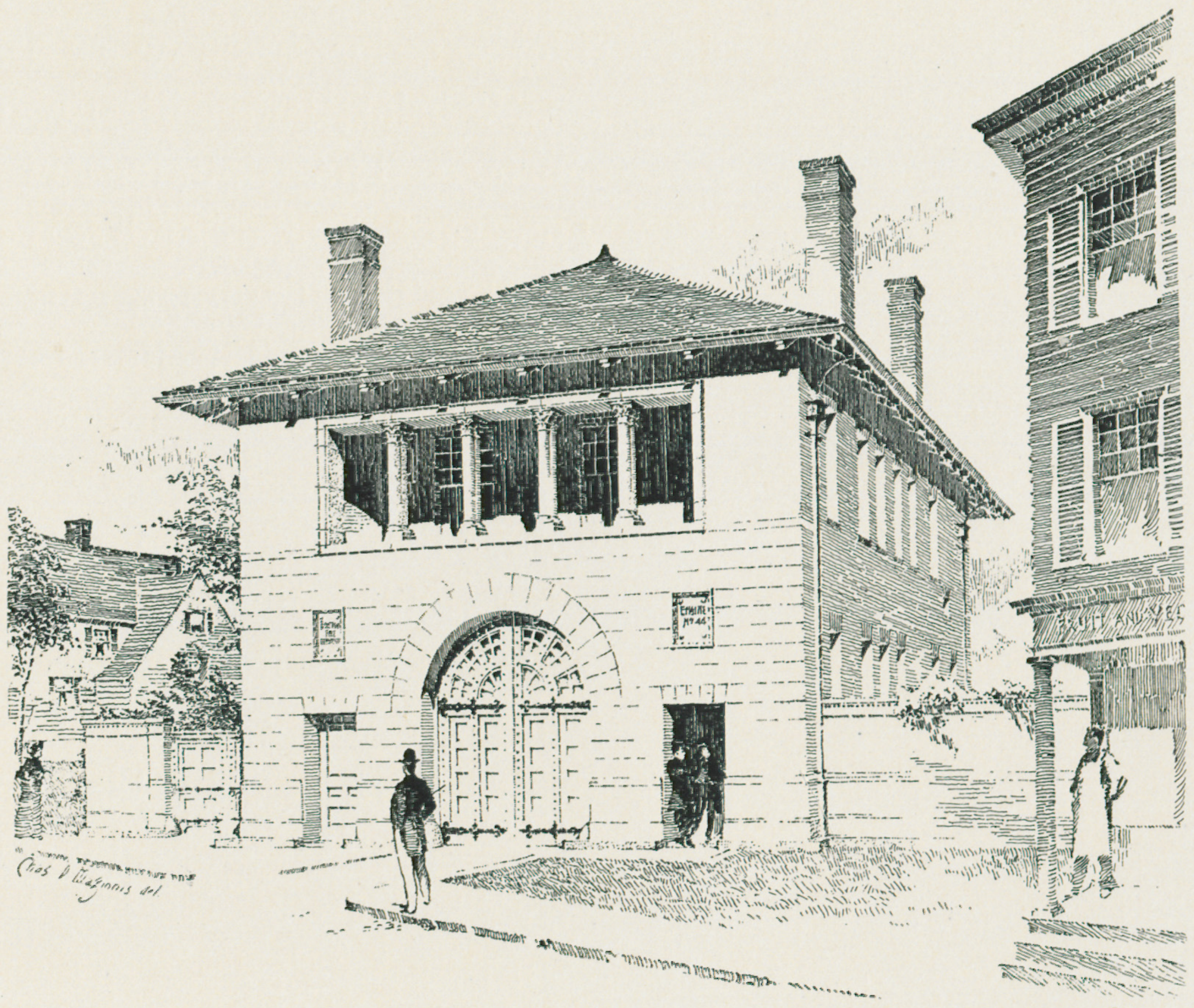
Finish and fixtures.

All bath rooms and lavatories have marble bases and walls lined to the ceiling with enameled brick. Floors, bases, and sills in water closets, toilet rooms, corridors, etc., are of Knoxville marble. All rooms of the second story have marble plinths, bases, and sills. The floors of shower and sponge bath rooms on the third floor are of asphalt. The stall posts run to the ceiling and are of iron 5 inches in diameter, bolted to 12 inch channel beams sunk in the concrete floor. Interior wood finish is kiln-dried brown ash. Where the walls are lined with brick, the windows have fine-axed bluestone sills. The apparatus room is lined with buff terra cotta brick; the walls of stable, tower, gymnasium, rear stairs, dynamo room, and hay lofts are lined with selected water struck brick. The front entrance doors are oak with glass panels protected by wrought-iron guards. The running track in the gymnasium is hung from the ceiling by iron rods. In the gymnasium shower room are four shower baths. The sponge baths have each a soapstone foot bath. The building is heated by steam with

direct and direct-indirect radiators. The steam for this purpose is carried from the power-house about 200 feet distant through pipes laid in a brick conduit. The stable and the rooms on each floor are ventilated by an electric exhaust fan. In the fourth story the space for the fire-alarm apparatus is enclosed by a railing and gate of polished brass. Switchboards and cases are built of white mahogany. While the system is operated by its own electrical power, connection can be made in case of emergency with the street service. The conduits for the wires in the fourth story floor are formed by 3 inch Akron pipe, with manholes. These conduits connect with others in the tower walls, which are accessible at each floor by means of iron doors. Extra precautions have been taken for protection against fire, as the building stands in a dangerous lumber district. A wrought-iron standpipe 5 inches in diameter runs from the ground to above the roof on the east side of the building, with hose connections at each of the balconies and the roof. From this pipe near the top, another pipe of from 4 to 2½ inches in diameter runs about the side and the front of the building. On the middle of each side is a revolving sprinkler, and on the front there are three sprinklers, the arms being of bronze metal and slightly curved. The cost of this building, exclusive of fire alarm apparatus, was about $90,000.00. The cost of the cabinet work for the fire alarm apparatus was $3,500.00. This building is further illustrated by Plates LXXV. to LXXVIII.

Ashmont Engine House.

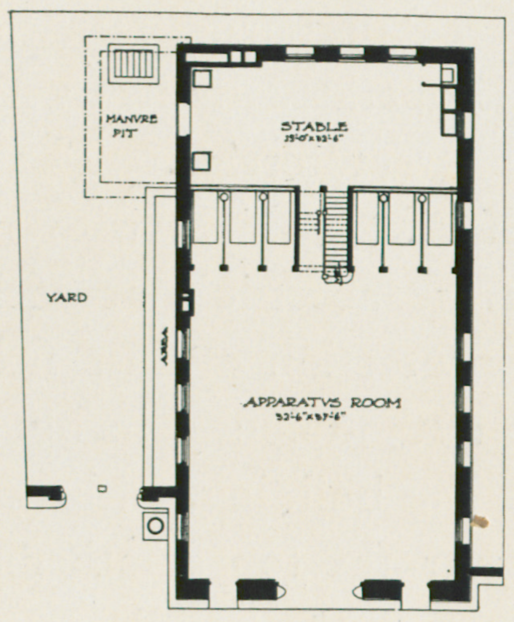
ASHMONT ENGINE HOUSE is on Dorchester avenue, Ward 24 (Dorchester). It is a single company house. On the first floor is the apparatus room, at the end of which is a six stall stable fitted with Lynn stall floors. The walls of apparatus room and stable are lined with Scotch firebrick. On the second floor are the captain's room, dormitory, locker room,



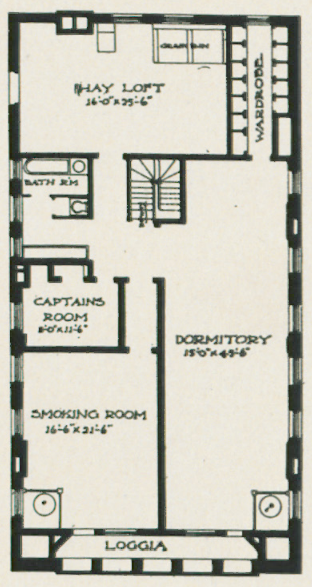
ASHMONT ENGINE HOUSE.

toilet room, bath room, smoking room, and hay loft. In the basement are toilet room, fuel room, washing troughs, and drying racks for hose. The basement floor is of asphalt. All other floors are of mill construction, with upper floors of Georgia pine. The partitions of the second story are of terra cotta lumber. The door and window trimmings are of Keene's cement. The exterior brick work is of Cartcraig Scotch firebrick, laid Flemish bond in white mortar, with Amherst stone trimmings. The roof has projecting eaves with cut rafter ends

of Georgia pine, and is covered with light green Vermont slate. Heating is by indirect radiation, with proper provision for ventilation. The building cost $21,413.41. It is further illustrated by Plates LXXII. and LXXIII.



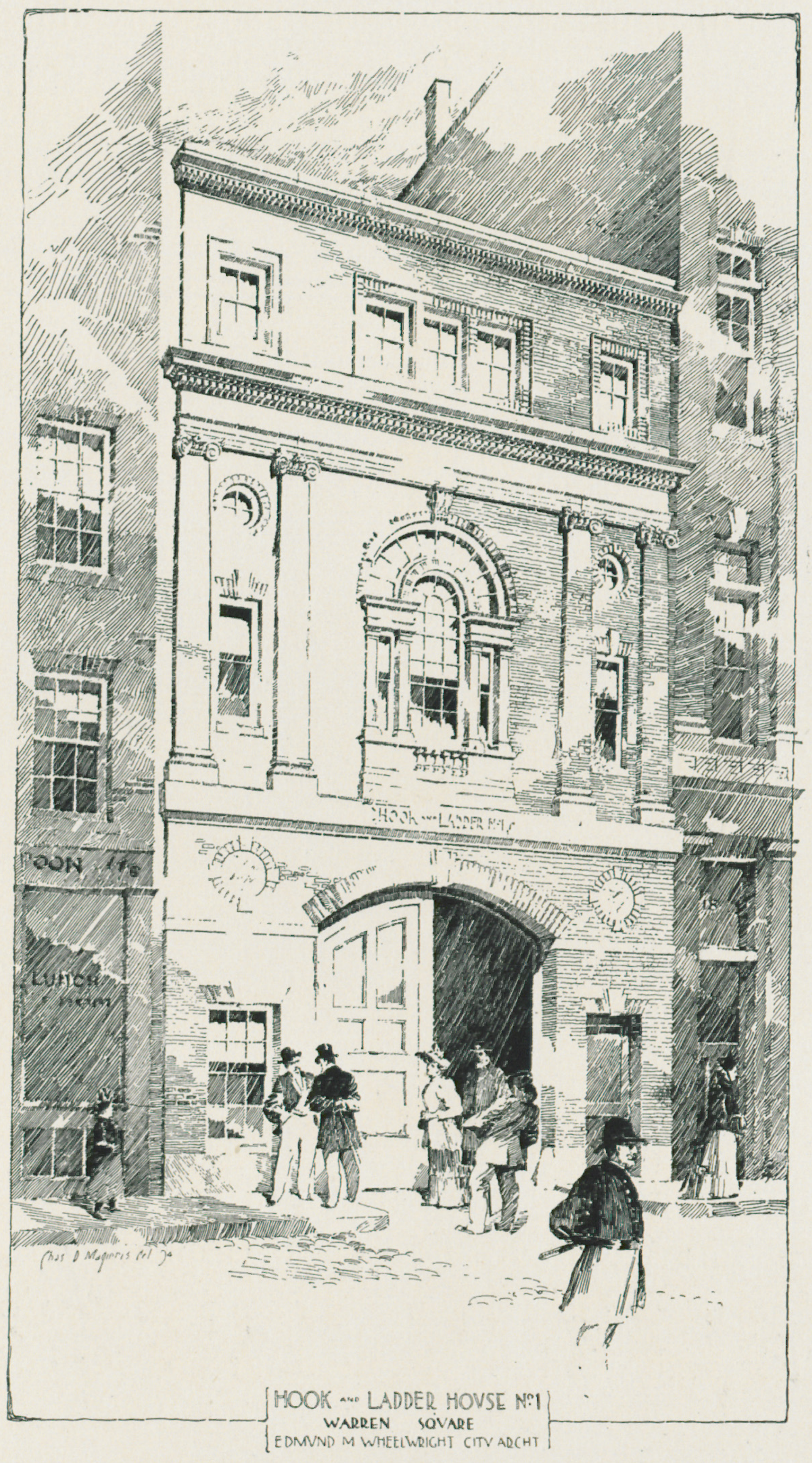
FIRST FLOOR PLAN.



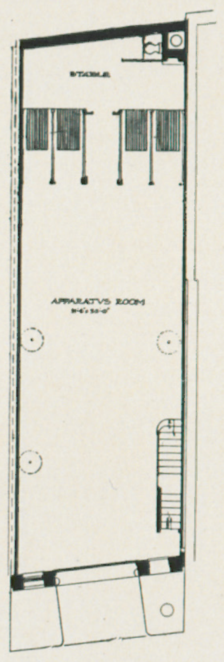
SECOND FLOOR PLAN.

Ladder House I.

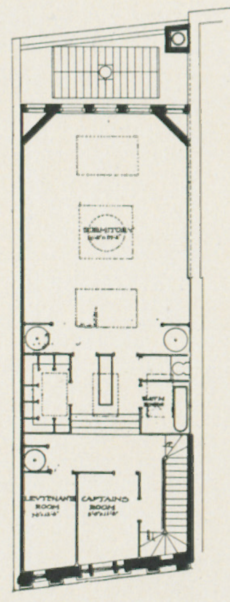
LADDER HOUSE I. is on Friend street, Ward 6. On the first floor are the apparatus room and the stable. A hay loft is arranged in a mezzanine floor above the stable. On the second floor are rooms for the captain and the lieutenant, the dormitory for the company, and toilet, bath rooms, etc. On the third floor is the smoking room. Sliding poles connect the upper floors with the apparatus room. As this building is in a block, the rear walls are stepped back on each story to give light. The windows on the front are placed high above the floor to prevent the men from leaning out. All parts of the building are amply lighted. The exterior brick work is of selected water struck brick, laid with Flemish bond in white mortar. The trimmings are of white marble. The roof is flat and covered with tar and gravel. The flashings, gutters, and conductors are of copper. The floors are of mill construction. Apparatus room and stable are lined with buff terra cotta brick. Partitions are channel iron. The basement floor is of asphalt; all the other upper floors are of rift Georgia pine. The interior trimmings are of Keene's cement. The cost was $18,918.21. This building is further illustrated by Plate LXXIV.



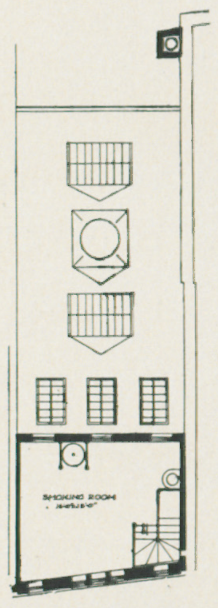
LADDER HOUSE I.



FIRST FLOOR PLAN.



SECOND FLOOR PLAN.

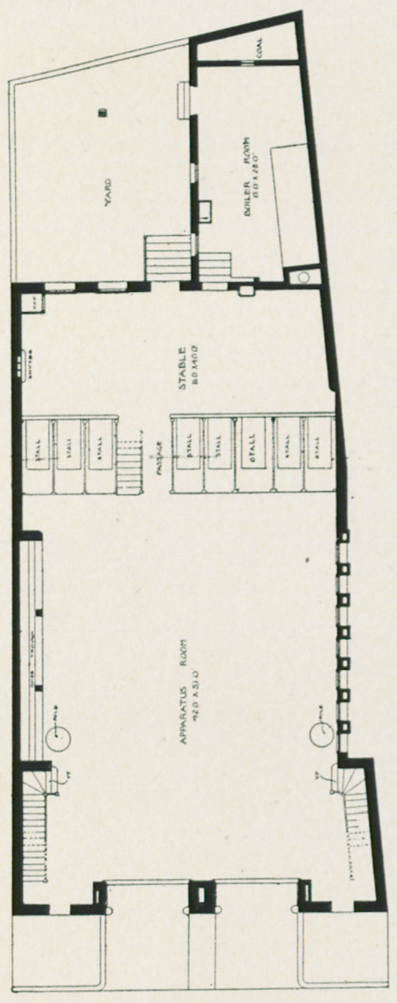


THIRD FLOOR PLAN.

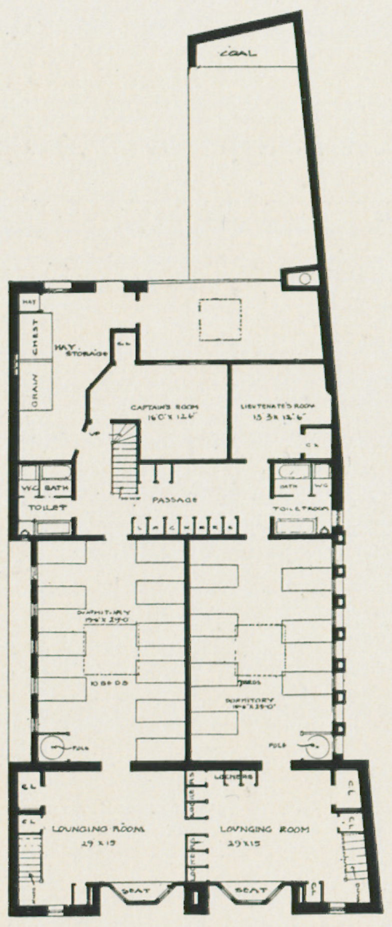
Andrew Square Engine House.

ANDREW SQUARE ENGINE HOUSE is on the square of that name in Ward 15 (South Boston). It is planned for an Engine and Ladder House. The exterior brick work is of selected red water struck brick, laid in white mortar, accentuated slightly with light buff terra cotta brick and with marble discs. The trimmings are of red terra cotta. Apparatus room and stable are lined with Scotch firebrick. The first story floor is of "Guastavino" tile construction. The second floor is a combination of steel truss and concrete also constructed by the Guastavino Company. This is the first engine house built for the City of Boston where a system of artificial ventilation was provided. The site of the building being but a few feet above mean high water, the basement could not be utilized. The boiler room was therefore placed at the rear a few feet below the level of the first floor, and the hose cleaning trough and drying racks, usually placed in the basement, were here of necessity put on the first floor. The cost of this building was about $26,000.00.

ANDREW SQUARE ENGINE HOUSE.



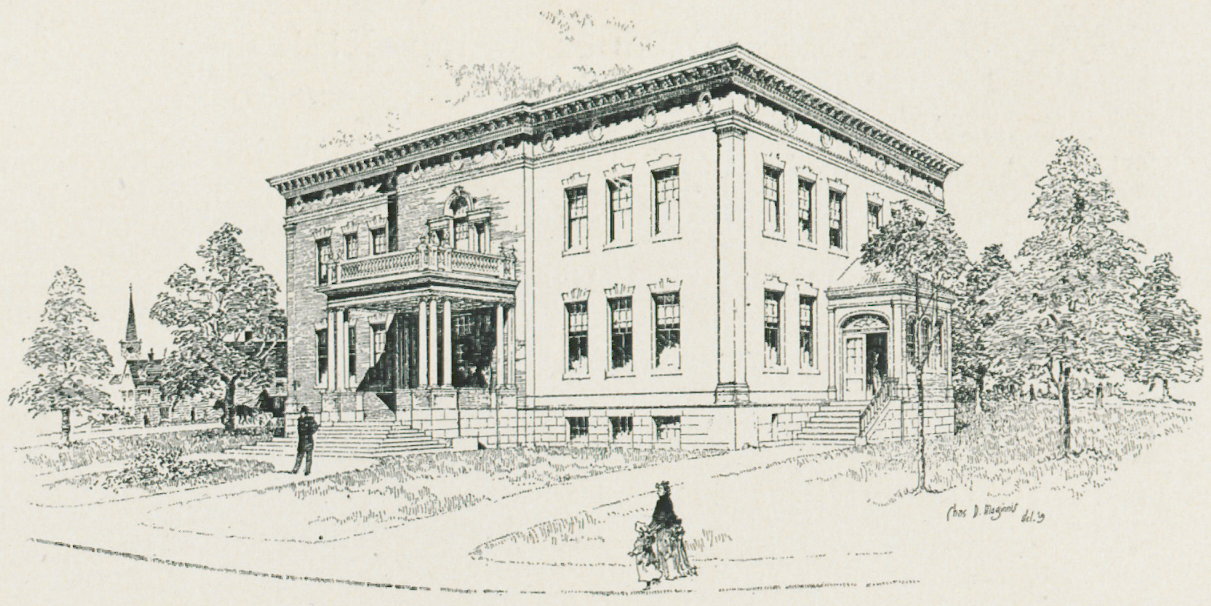
FIRST FLOOR PLAN.



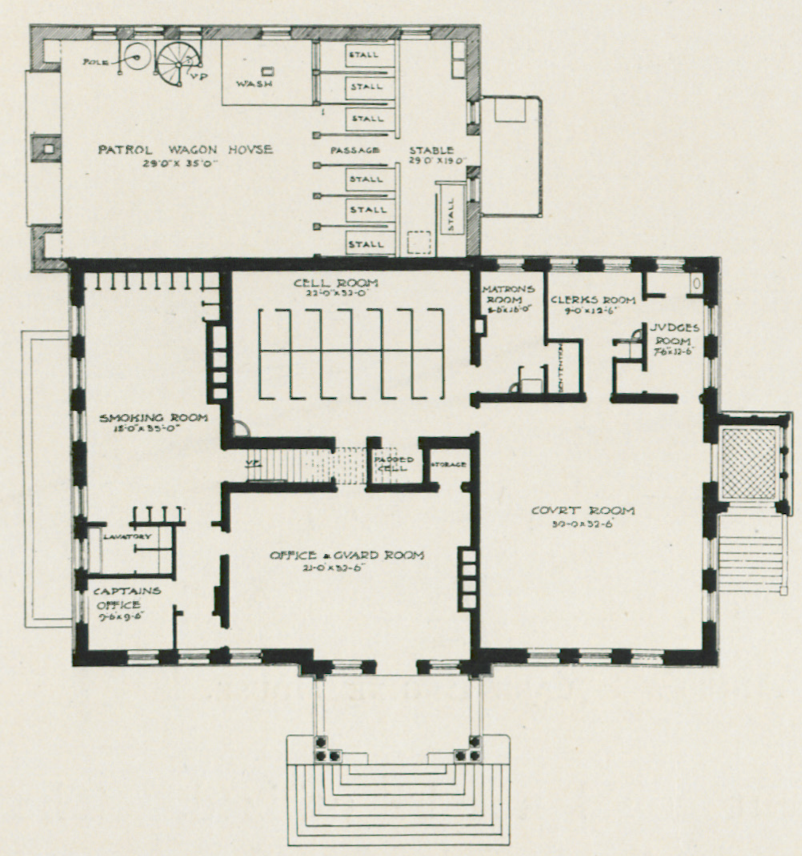
SECOND FLOOR PLAN.

Brighton Police Station.

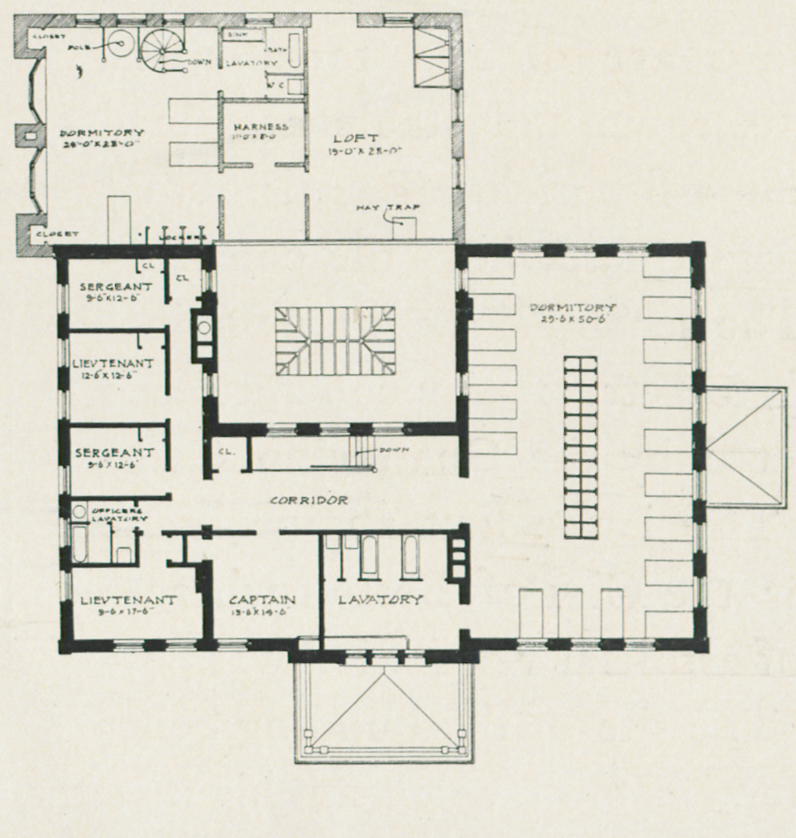
BRIGHTON POLICE STATION is on Washington street, Ward 25 (Brighton). The underpinning is of granite. The full design included a Patrol Wagon House which has not yet been constructed. The exterior brick work is Cartcraig Scotch firebrick with light buff terra cotta trimmings. The discs in the frieze are Siena marble with framing of terra cotta. The entrance porch is of white pine



painted light buff, with exterior steps of North River bluestone. The building has a flat tar and gravel roof. Heating is by indirect radiation, the ventilation being well provided for. The cost of the building was $41,805.30. It is further illustrated by Plates LXXIX. and LXXX.



FIRST FLOOR PLAN.

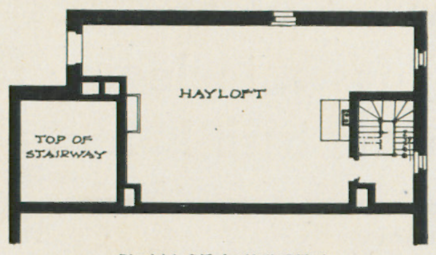


SECOND FLOOR PLAN.

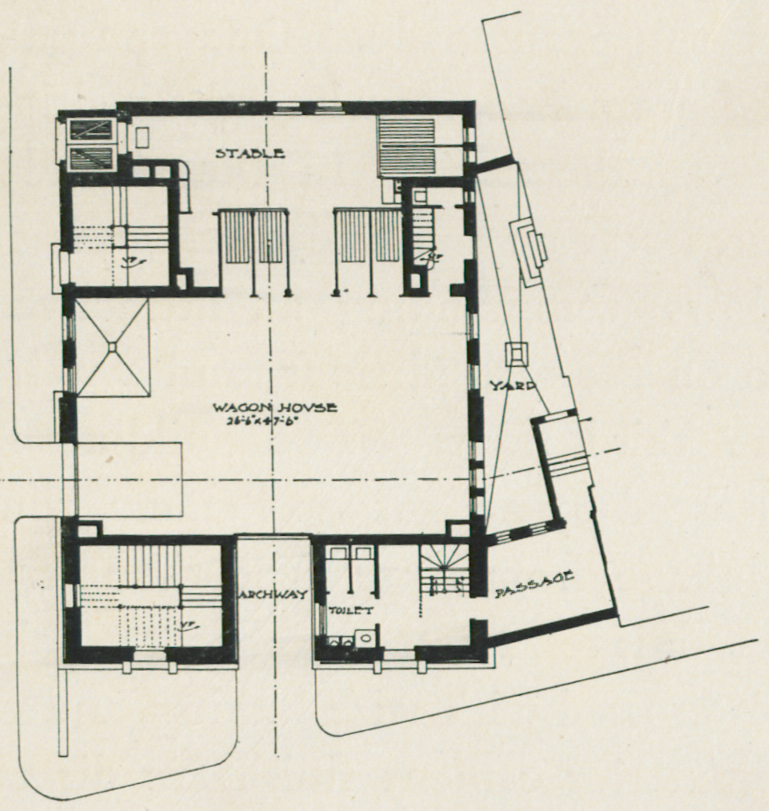
Patrol Wagon House and Court Room for Police Station XIII.

THE PATROL WAGON HOUSE AND COURT ROOM for Police Station XIII. is on Maple place and Starr lane, Ward 23 (Jamaica Plain). On the first floor are a room 30 by 40 feet for the patrol wagon and ambulance, and a stable. The stable has four stalls for "quick hitch up," and two ordinary stalls for spare horses. All the stalls are fitted with Lynn stall floors with maple plank strips over them. The floors of the wagon room and the stable are of checkered asphalt. In the second story is the Municipal Court Room, to which there are a public staircase, a private staircase for court officers, and a staircase for criminals which is connected by a covered way with the cells in the basement of the Station House, the first floor of which is at about the level of the Court room. On the front in this story are the private rooms for the Judges and the Clerks of Court. The room back of the court room, over the stable, is divided into two stories. The lower room is a dormitory and is connected with the stable by its own staircase. Above this room is a hay loft. The exterior is of selected red water struck brick, laid Flemish bond in red mortar. The trimmings are of red terra cotta, with window stools of Longmeadow stone. The heating is by indirect radiation supplemented by direct coils and radiators. The building cost $23,971.97. It is further illustrated by Plates LXXXI. and LXXXII.

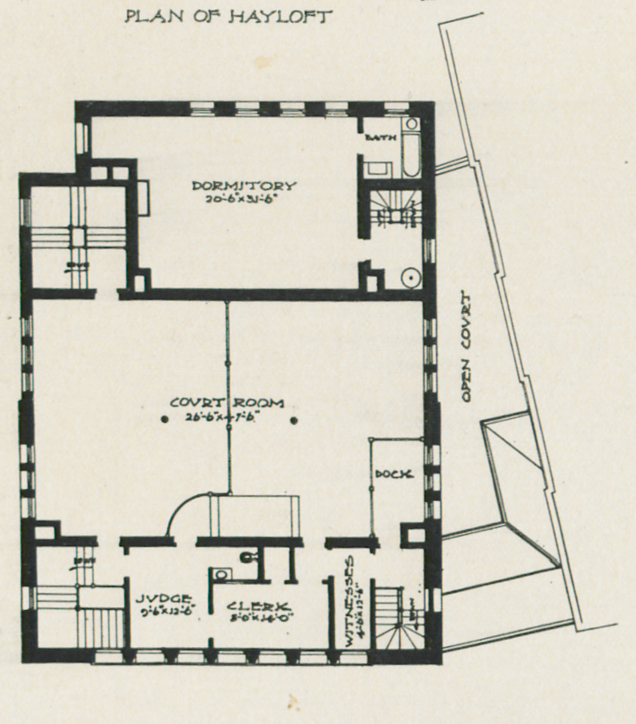
Annex to Police Station XIII.



PLAN OF HAYLOFT



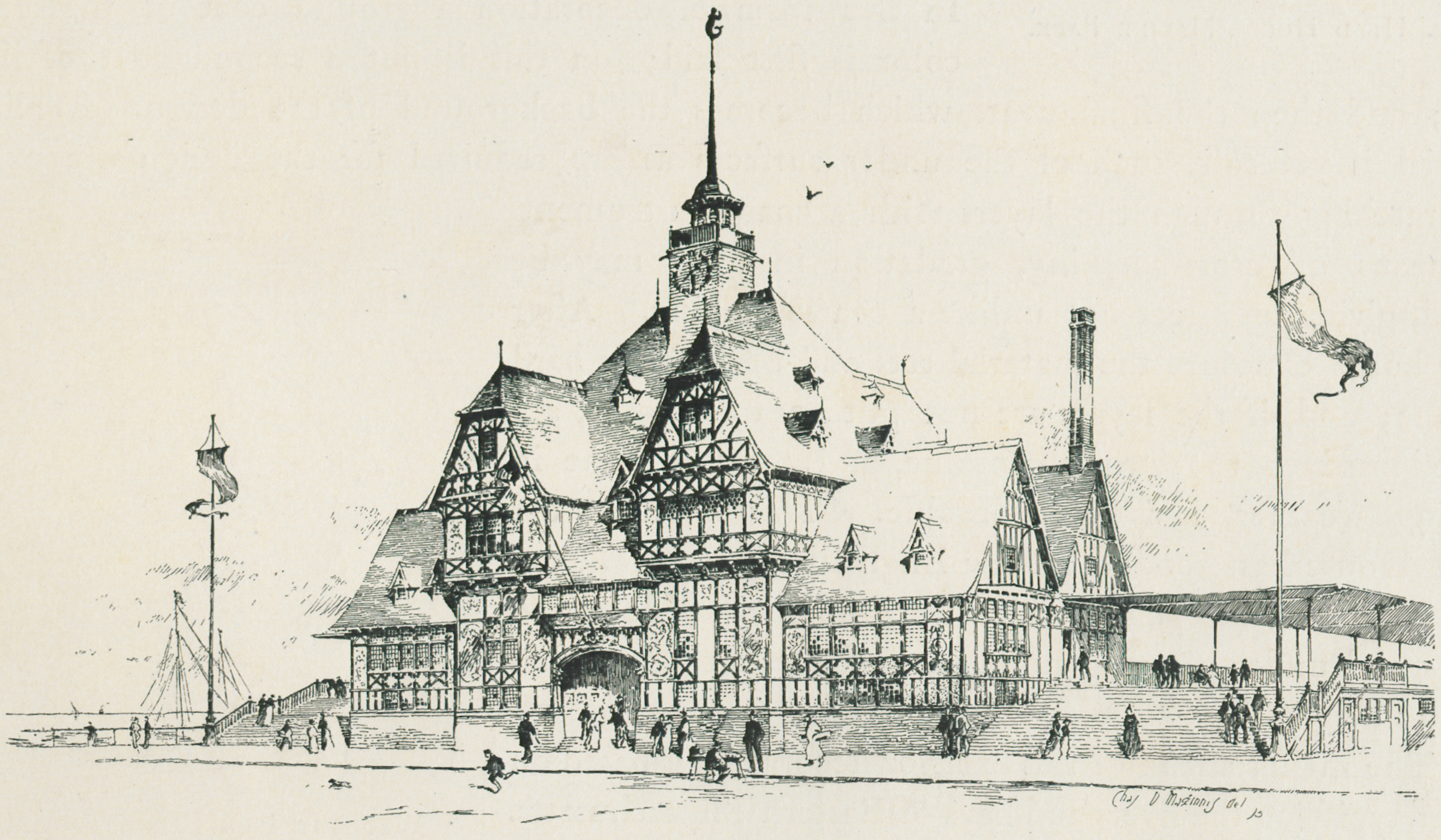
FIRST FLOOR PLAN.



SECOND FLOOR PLAN.

Head House, Marine Park.

THE HEAD HOUSE, the largest and most important building yet built by the Boston Park Commission, stands at the entrance to the pier at Marine Park, City Point, South Boston. It is planned for two purposes: to give accommodation for sea bathing, and to serve as a restaurant for the frequenters of the pleasure pier. The design of the building fits the splendid site and expresses well the idea of a place for recreation. The architectural treatment is that found in the half-timbered work of North Germany. It is charming in its picturesque and fanciful character and yet impressive in its dignity. The ground floor is arranged primarily for the bathers. The main entrance gives on a general waiting room. This large room is handsomely finished in ash, the ceiling showing heavy beams with plaster panels. Immediately adjoining



HEAD HOUSE, MARINE PARK.

and on either hand of this waiting room are the toilet rooms. In the rear are placed five hundred bath houses, including thirty-two shower baths. A separate system of toilet rooms is connected with the bath houses only. At each side of the building are broad steps leading to the promenade. A passageway over the bath houses connects the two sections of this promenade. One can pass down on both sides from the promenade level to the waiting room, or up by a few steps to the cafés. In the second story, approached by a staircase from the café corridor, is a restaurant with eastern windows commanding an attractive sea view. The kitchen is also on the second floor, and a well appointed laundry is on the third floor. The building is of wood construction re-enforced by a light steel frame, thus reducing the trouble of shrinkage from large sized timbers. The filling between the frame is terra cotta lumber, the joint between frame and blocks is crossed with wire lathing, and the interior plastering and the exterior cement finish are directly applied to this construction. The window glass is leaded in small panes. The roof is of dark Monson slate. On the base of the cupola is a clock face of gilded iron. The minute hand is a trident, impaling a dolphin, the hour hand is a harpoon; the hour points are cuttlefish, the minute points are the crests of a conventional wave pattern. The flèche is terminated by a mermaid in beaten copper serving as a weather vane.

FLÈCHE, HEAD HOUSE, MARINE PARK.

Sgraffito decoration.

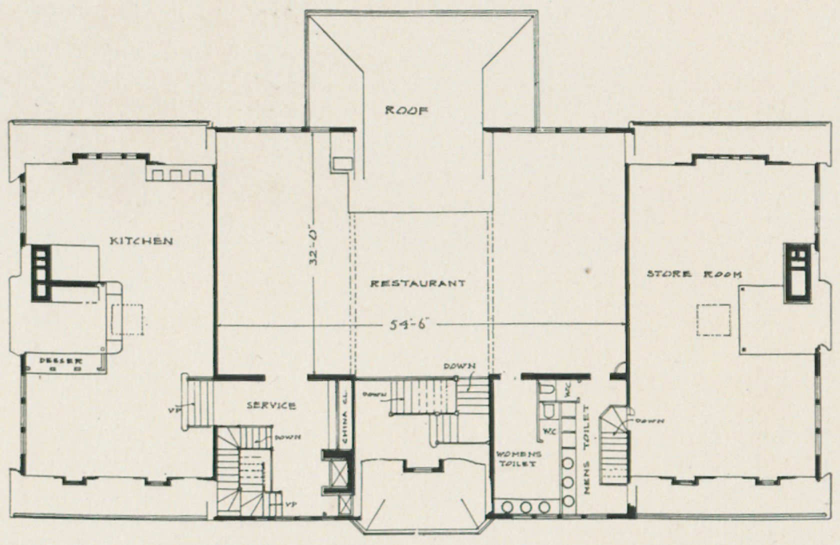
The color scheme of the building is an important factor in its design. The half-timber work of Georgia pine is stained a very dark brown. The colors of the panels formed by the half-timber work are gray, yellow ochre, and dark brown. These panels are decorated in sgraffito, that is, designs scratched in cement or plaster before it becomes set. In this form of decoration a ground coat of the darkest color is first laid; on this is put a second coat of lighter color; and then the final coat, which becomes the background of the design. While the material is yet soft, such of the under surfaces as are required for the design are exposed by scratching through the layers with a sharp instrument. By means of cross-hatching, gradation in tone may be gained, giving an effect not unlike a coarse etching. After a few hours' exposure the material sets and becomes as hard as stone; and, if the layers are not put on too hastily, are not exposed to too strong sunshine, and are not done in freezing weather, it is very durable. This work at the Head House has stood the New England climate well, except that on a few panels which were apparently done too hastily and under a strong sun a part of the outer layer has peeled off.

WROUGHT IRON CLOCK FACE, HEAD HOUSE, MARINE PARK.

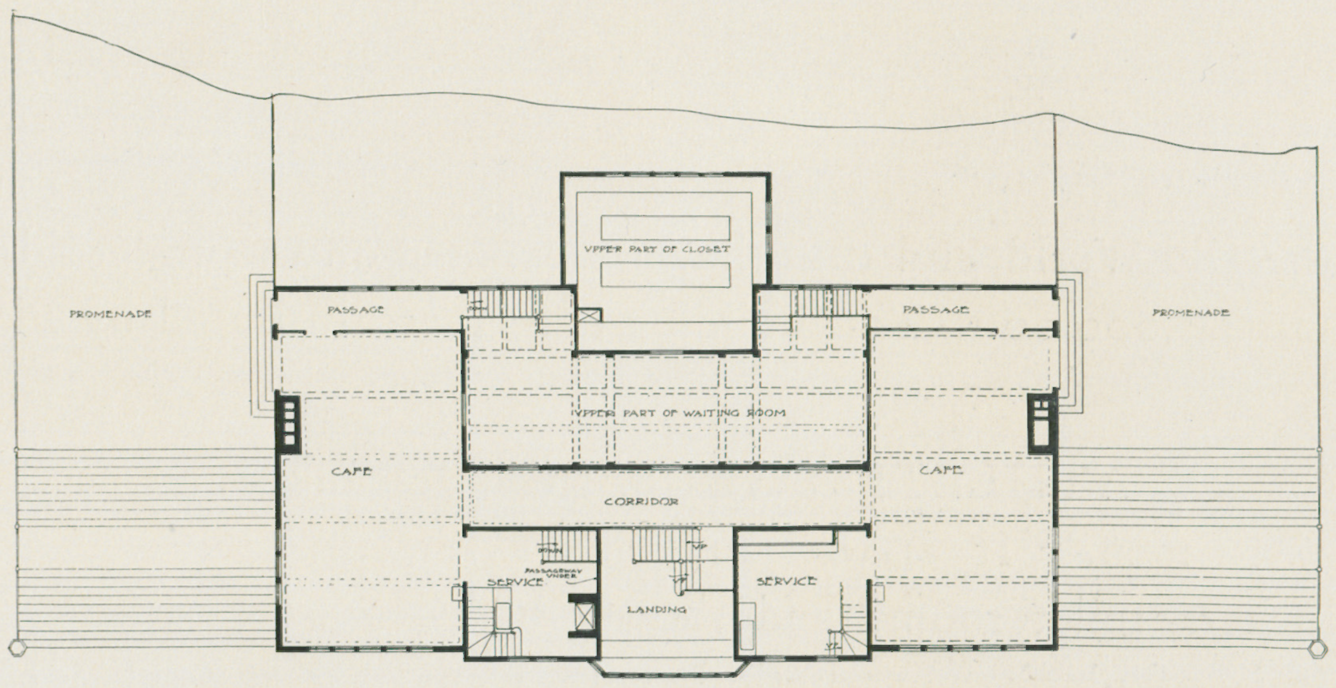
Subjects of Panels.

The main scheme of this exterior decoration is based on figures typifying the rivers and bays of Eastern Massachusetts. In the panel immediately on the left of the carved wooden

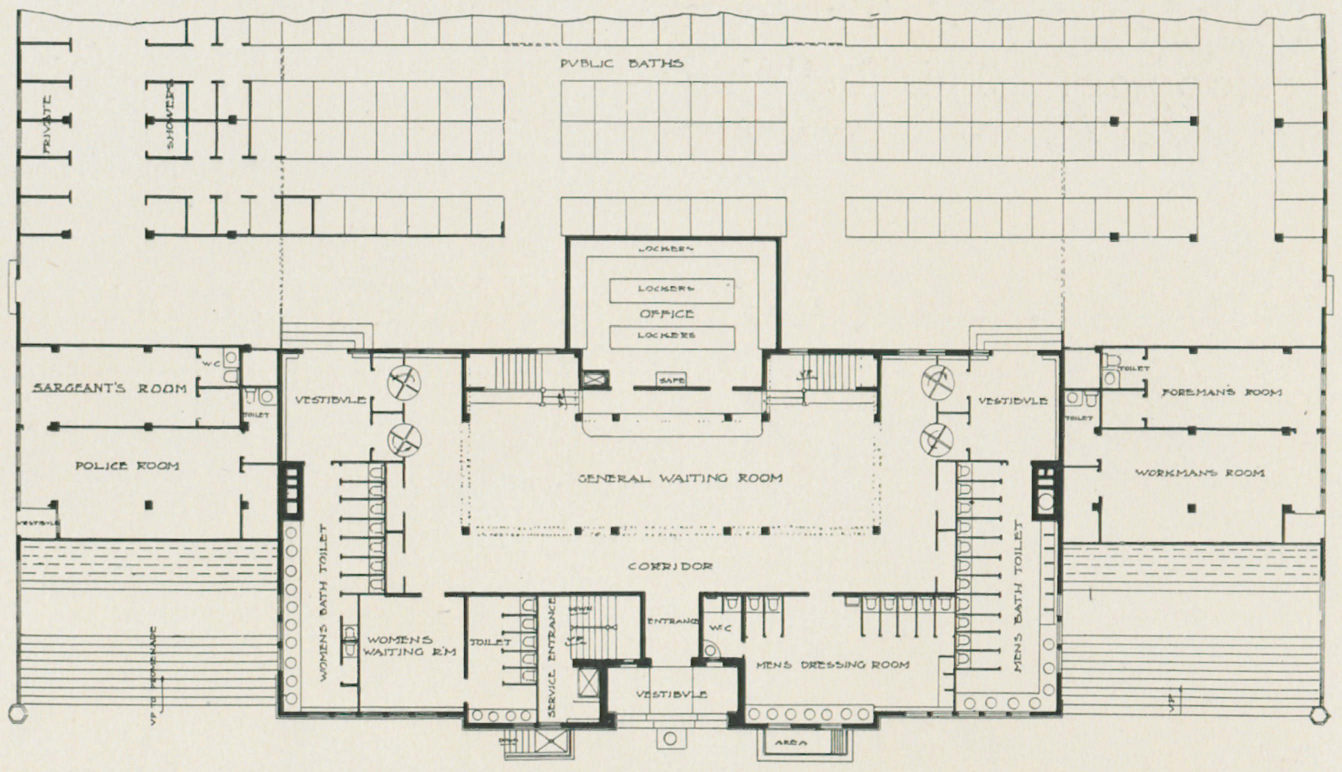
archway of the entrance, of which the principal feature is the Seal of the City of Boston, is the figure of a Puritan magistrate who holds in his hand the Charter of the Colony and represents "Massachusetts Bay." Balancing this figure, another in plainer attire, holding a Bible, typifies "Plymouth Bay." In the next two balancing panels are "The Merrimac" and "The Charles," the one an Indian with a fish spear and a sturgeon, the other a Viking, recalling the apocryphal traditions of the early discovery of this river by Norsemen. In smaller panels four rivers, "The Weymouth," "The Mystic," "The Ipswich," and "The Neponset" are typified, each by two figures in arabesque scrollwork. Indian girls and boys are used in the first two panels, and "Yankee" boys of Colonial times in the other two, of which one group typifies Fisheries, and another Ship Building, the two early industries of the Bay State. Above and about the principal panels are figured arabesques in which sport dolphins and other sea monsters, and tritons and frolicking mermaids. Four large panels, two on either side of the building, show four vessels of past times: a "Norse Galley," "Captain John Smith's Vessel," the "Mayflower," and the "Constitution." The panels on the inner walls of the main entrance show the archaic decorative colors, red, yellow, and black. Here in a large panel over the main door is the ancient seal of the Bay Colony, and in the cartouche panels which decorate the remainder of this wall and the two side walls of the porch are the dates of famous events in the history of this region,— the landing of the Pilgrims, 21 December, 1620; the arrival of the Arabella, 22 June, 1630; the settlement of Boston, 17 September, 1630; the overthrow of Andros, 18 April, 1689; the Boston tea party, 16 December, 1773; the battle of Lexington, 19 April, 1775; the battle of Bunker Hill, 17 June, 1775; and the evacuation of Boston, 17 March, 1776. The traditional codfish fills the spandrils on the inside of the entrance arch. The general decorative scheme was designed by Mr. Wheelwright, and the work was executed by Mr. Max Bachman.



SECOND FLOOR PLAN.



FIRST FLOOR PLAN.



GROUND FLOOR PLAN.

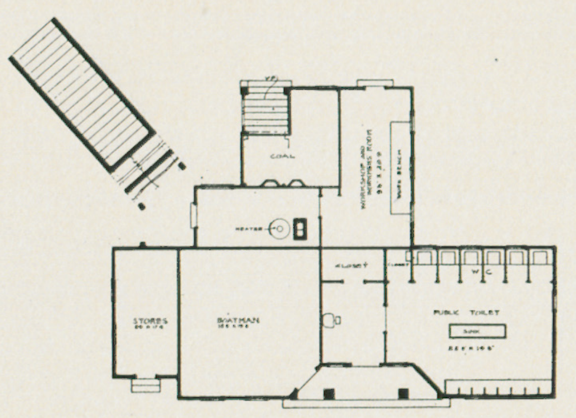
The cost of this building, inclusive of bath houses and promenade adjoining, but exclusive of laundry machinery, electric plant, and kitchen outfit, was $96,000.00, of which $3,280.00 was for the sgraffito decoration. This building is further illustrated by Plates LXXXIX. to XCIII.

Shelter, Franklin Park.

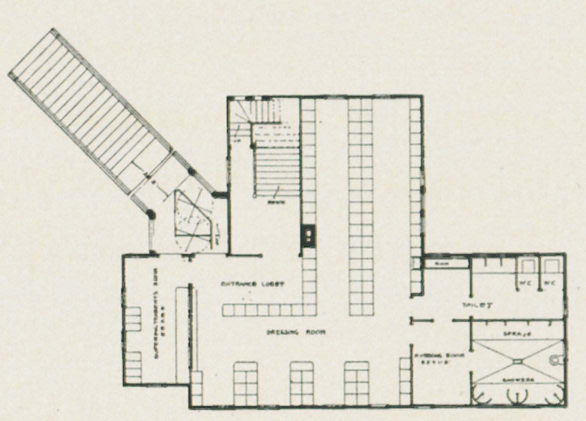
THE SHELTER at Franklin Park is the joint work of Mr. F. L. Olmsted, the landscape architect, and Mr. Wheelwright. The stone piers were built under Mr. Olmsted's direction, and according to his plan the building was to have a thatch roof. As this method of roofing, however, is liable to destruction by rats and squirrels, the plan was abandoned, and the roof was made of dark reddish-brown glazed Spanish tiles, the roof framing being of Georgia pine. The tiles are like those used on the roof of the Boston Public Library, but they are of a redder tone. They are laid on battens, after the fashion of such roofs in the Old World, and thus they are exposed on the under side. The cost of this roof construction was $4,600.00. This building is further illustrated by Plate LXXXIII.

Athletic House, Charlesbank.

THE ATHLETIC HOUSE, Charlesbank, is an accessory of the open air gymnasium for men. It is well furnished with lockers, toilet rooms, and shower baths. It is of plank construction, with walls and roof covered with unstained shingles of Oregon cedar. The cost was about $12,000.00. This building is further illustrated by Plate LXXXIV.



FIRST FLOOR PLAN.



SECOND FLOOR PLAN.

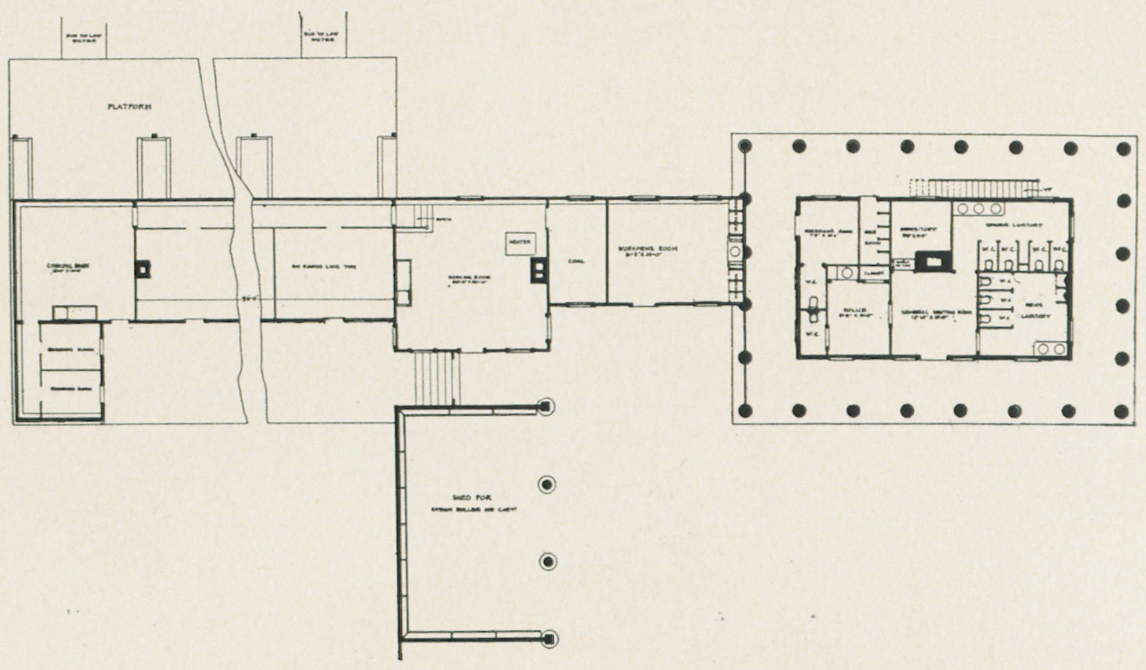
Proposed Shelter, Castle Island.

THIS SHELTER was designed for Castle Island in Boston Harbor, upon which stands Fort Independence. Under certain conditions the Federal Government has permitted the use of this island as a pleasure ground under the control of the Boston Park Commission. It was proposed that there should be in this building a central pavilion in which was to be a room for a boatman, and for booths for the sale of small wares or light refreshments. On either hand were to be covered promenades and toilet rooms for men and women. The plan provided for an outlook in the second story. The construction was to have been of Georgia pine, the outer casing to be of shingles. The shelter was not built.

SHELTER, CASTLE ISLAND.

Proposed Shelter for the Fens.

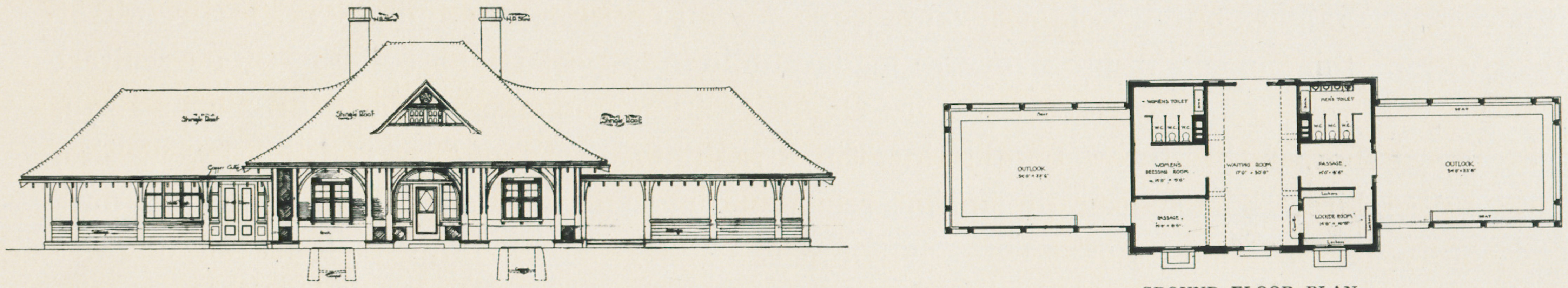
A SHELTER, designed for the Fens, is shown in the accompanying plan. This Shelter was to have been Japanese in character, and in the design Mr. Wheelwright profited by suggestions from Professor E. S. Morse. The roof was to have been of red unglazed tile, thus meeting the wishes of Mr. F. L. Olmsted, who desired to have a spot of warm color at this point in his landscape scheme. The structure was not built. It is further illustrated by Plates LXXXVI. and LXXXVII.



SHELTER FOR THE FENS.

Proposed Boating House, Jamaica Park.

THE BOATING HOUSE on the shore of Jamaica Pond was designed to be placed upon the axis of Pond street. The plan shows in the central pavilion a waiting room 17 feet by 50 feet, with toilet rooms for men and women on either hand. Here also is a locker



FRONT ELEVATION. GROUND FLOOR PLAN.

BOATING HOUSE, JAMAICA PARK.

room. Wide passages lead to outlooks in the two wings. It was intended to set sash between the posts of these wings during the winter. This structure was not built. It is further illustrated by Plate LXXXVIII.

Skating House, Franklin Park.

THE SKATING HOUSE at Franklin Park, illustrated by Plate LXXXV., was not built.

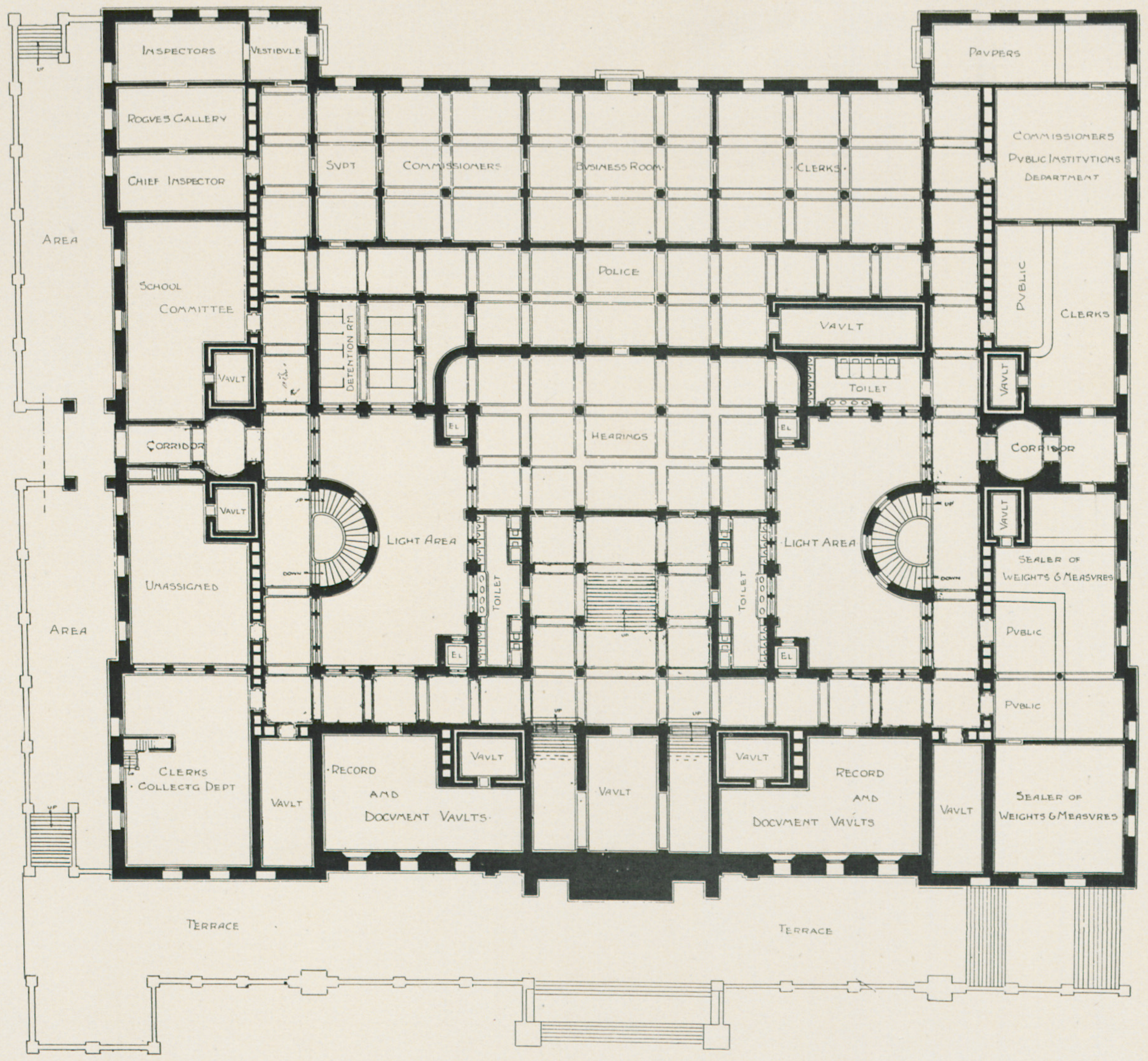
VI.

Proposed City Hall on Beacon Hill.

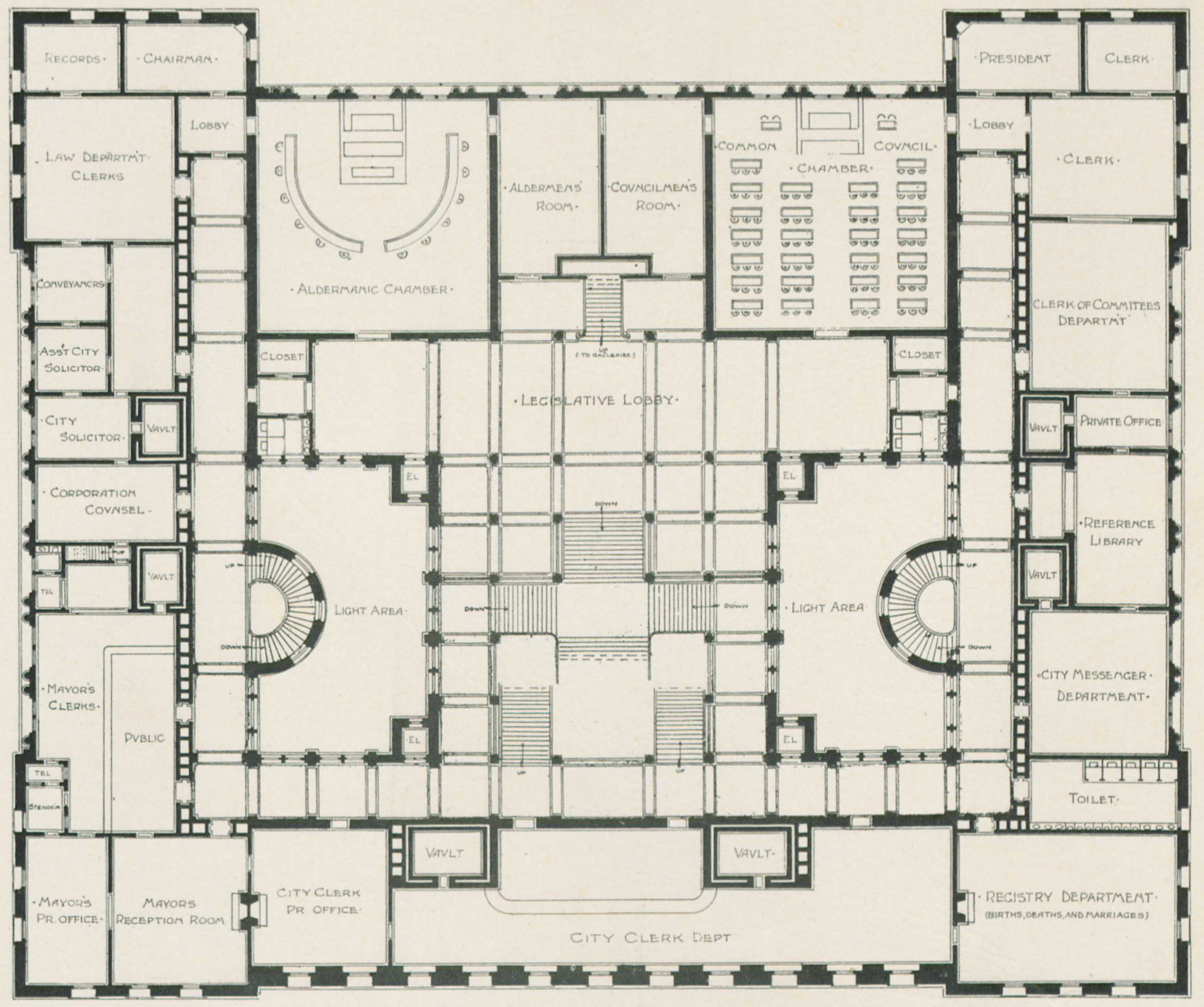
MAYOR MATTHEWS, recognizing the inadequacy of the present Boston City Hall, and the need of increased accommodation for the departments of the City in other than private buildings, in December, 1891, instructed the City Architect first to investigate and report upon the feasibility of putting up a new building on the old Court House site, connecting this with the present City Hall; and second to consider carefully such other sites as might appear to him advantageous for an entirely new building. The result of the study of this important problem was made public in a special report of the City Architect which the Mayor transmitted to the City Council with a message, dated February 8, 1892. This report showed that before considering the advisability of a new City Hall on a new site, the City Architect had made a design for reconstructing and enlarging the old Court House and connecting its upper stories with the present City Hall by a bridge. The building was designed to be of the height limited by law, 125 feet above the sidewalk. To gain upon the limited area the width of 25 feet which is necessary for all public department offices, it was necessary to plan for the sidewalk to be arcaded, so that above the first story the main walls of the building could be carried out as far as the outer edge of the present sidewalk line. The cost of this change, including the requisite alterations in the City Hall, was estimated at about $1,400,000.00. The departments even then would have been inadequately accommodated in such a building, and there would be no opportunity for further extension. It was therefore judged to be poor economy to make such use of the Court House site. The report accordingly submitted plans for a new City Hall to be built on Beacon Hill. The site chosen was the lot bounded by Beacon street, Somerset street, Ashburton place, and Bowdoin street. The cost of the proposed building was estimated upon a very conservative basis. By comparison with the known cost of the State House Extension and the New Court House (45 cents per cubic foot not including light areas), an estimate was reached which made full provision for every possible expense. The following is the summary of the probable cost as it was given in this report:—

Estimated cost.

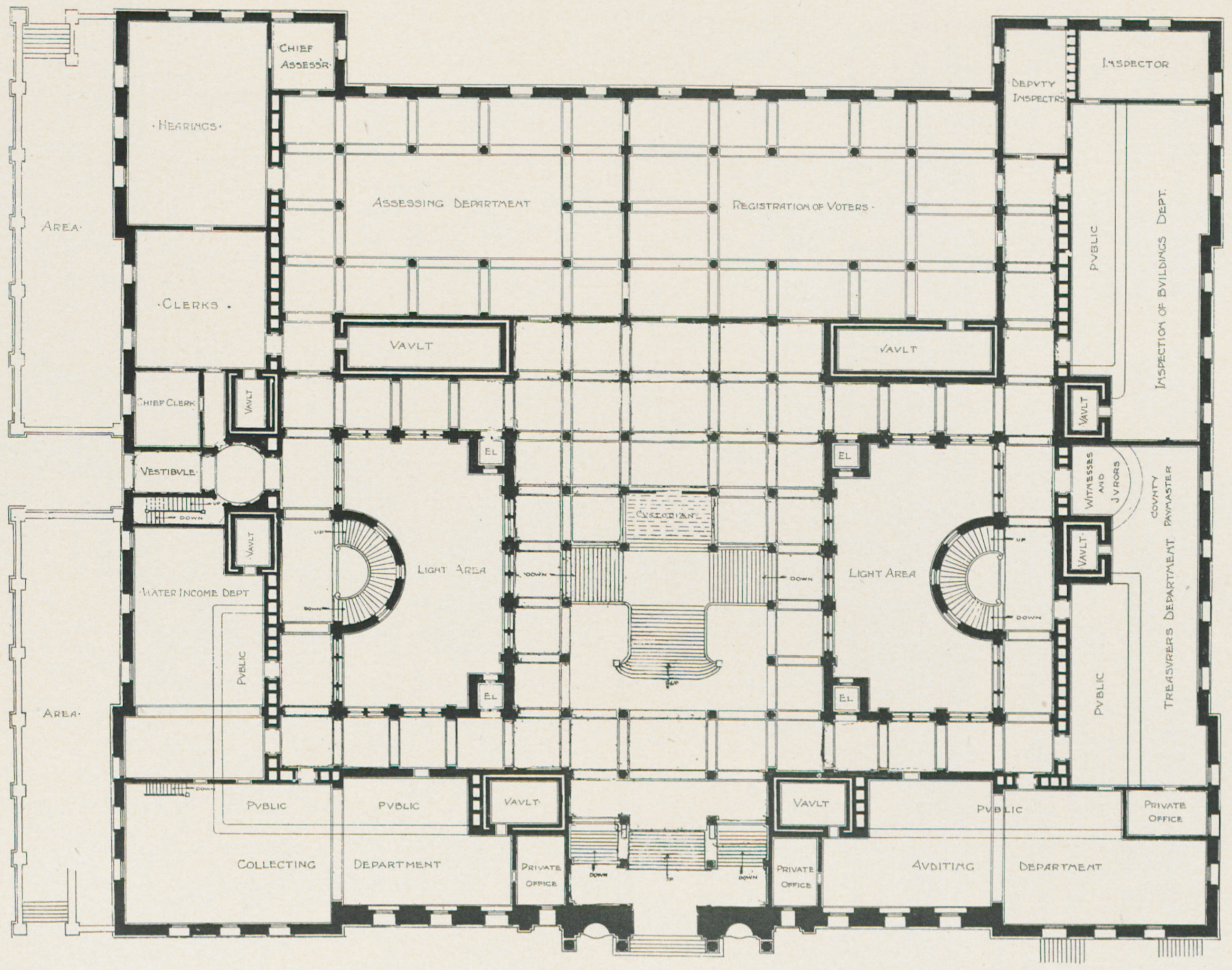
Market value of City Hall and old Court House property for private purposes	$2,055,060
Market value of Mason street property occupied by School Committee	158,000
	$2,213,060
Probable cost of site on Beacon Hill	1,917,120
Probable difference in value of the two sites	$295,940
Estimated cost of new City Hall, Beacon Hill	$2,400,000
Probable difference in value of the two sites	295,940
Probable net cost of building and site on Beacon Hill	$2,104,060



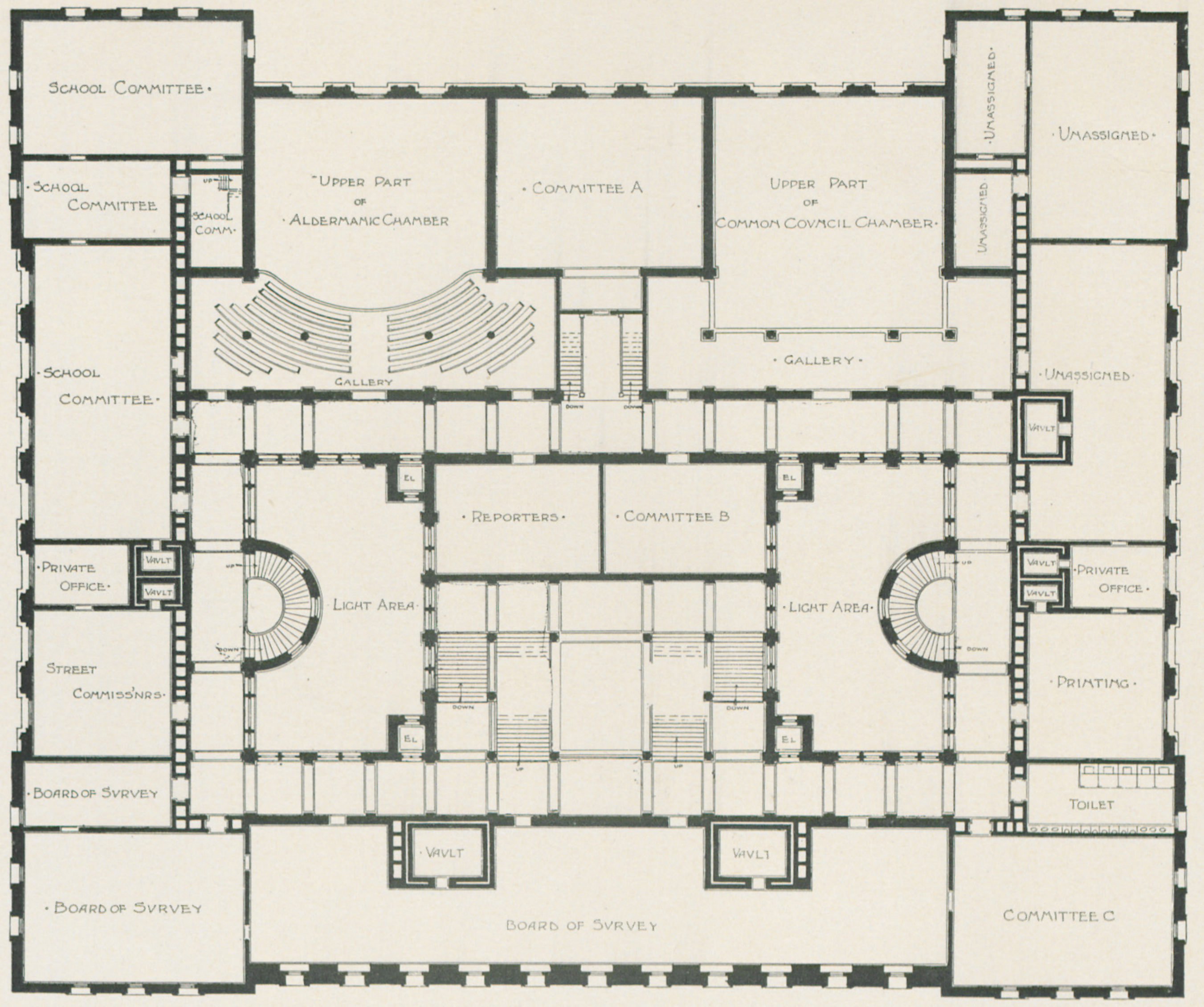
BASEMENT PLAN.



SECOND FLOOR PLAN.

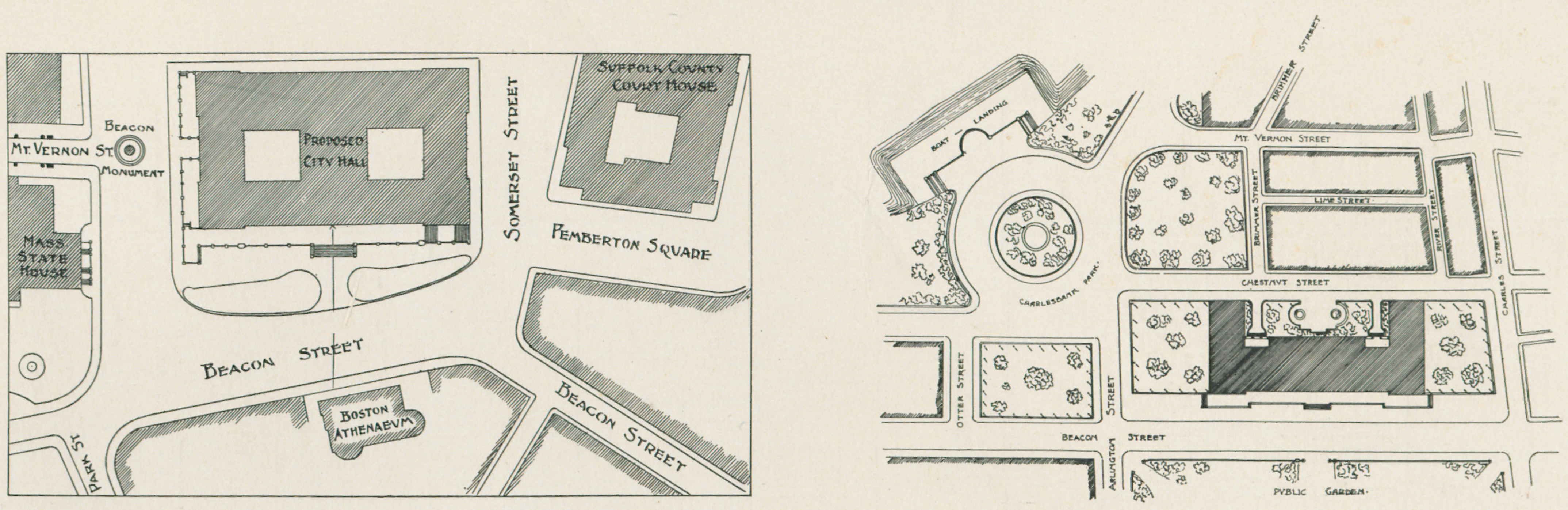


FIRST FLOOR PLAN.



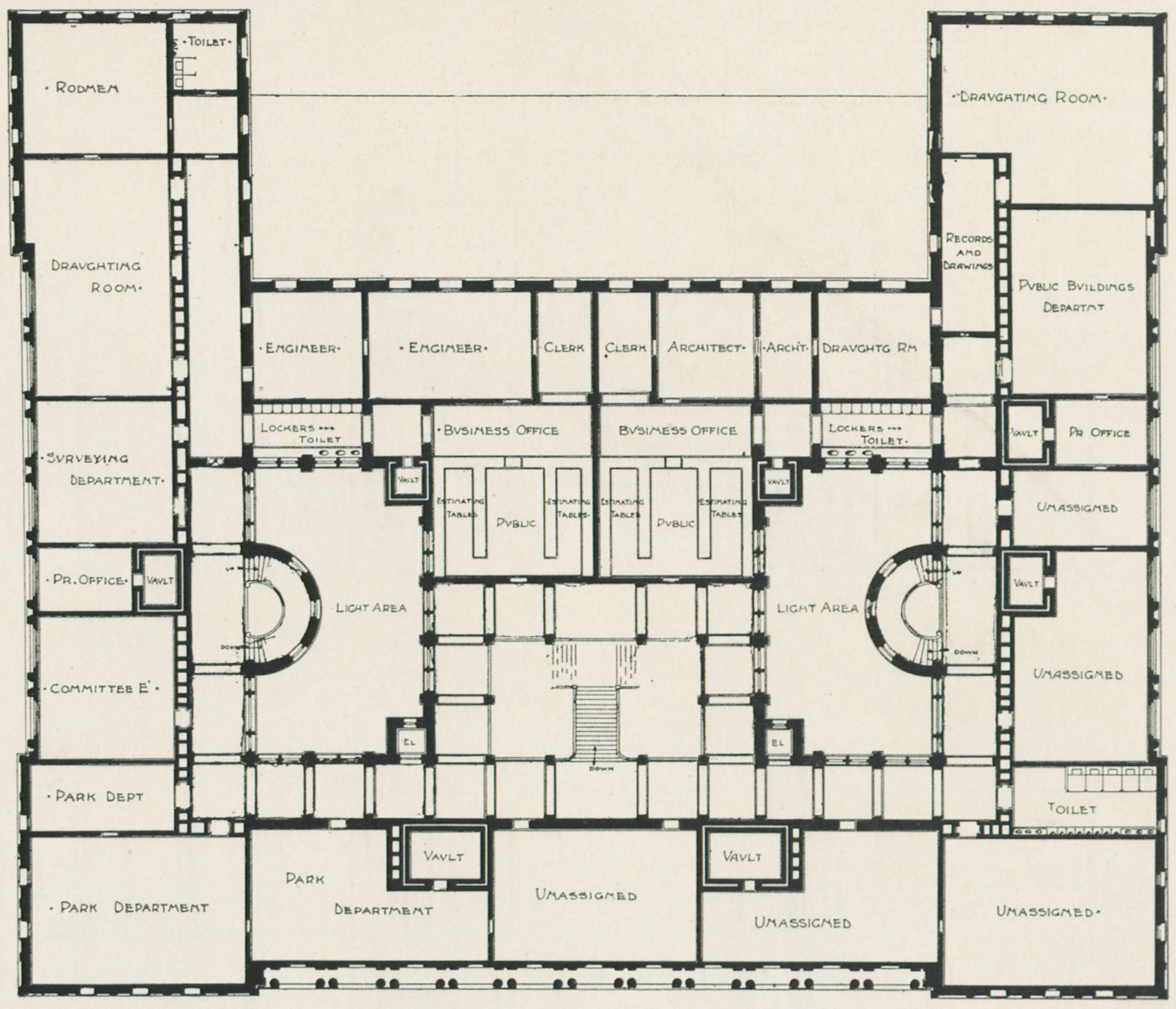
THIRD FLOOR PLAN.

PLANS FOR PROPOSED CITY HALL.



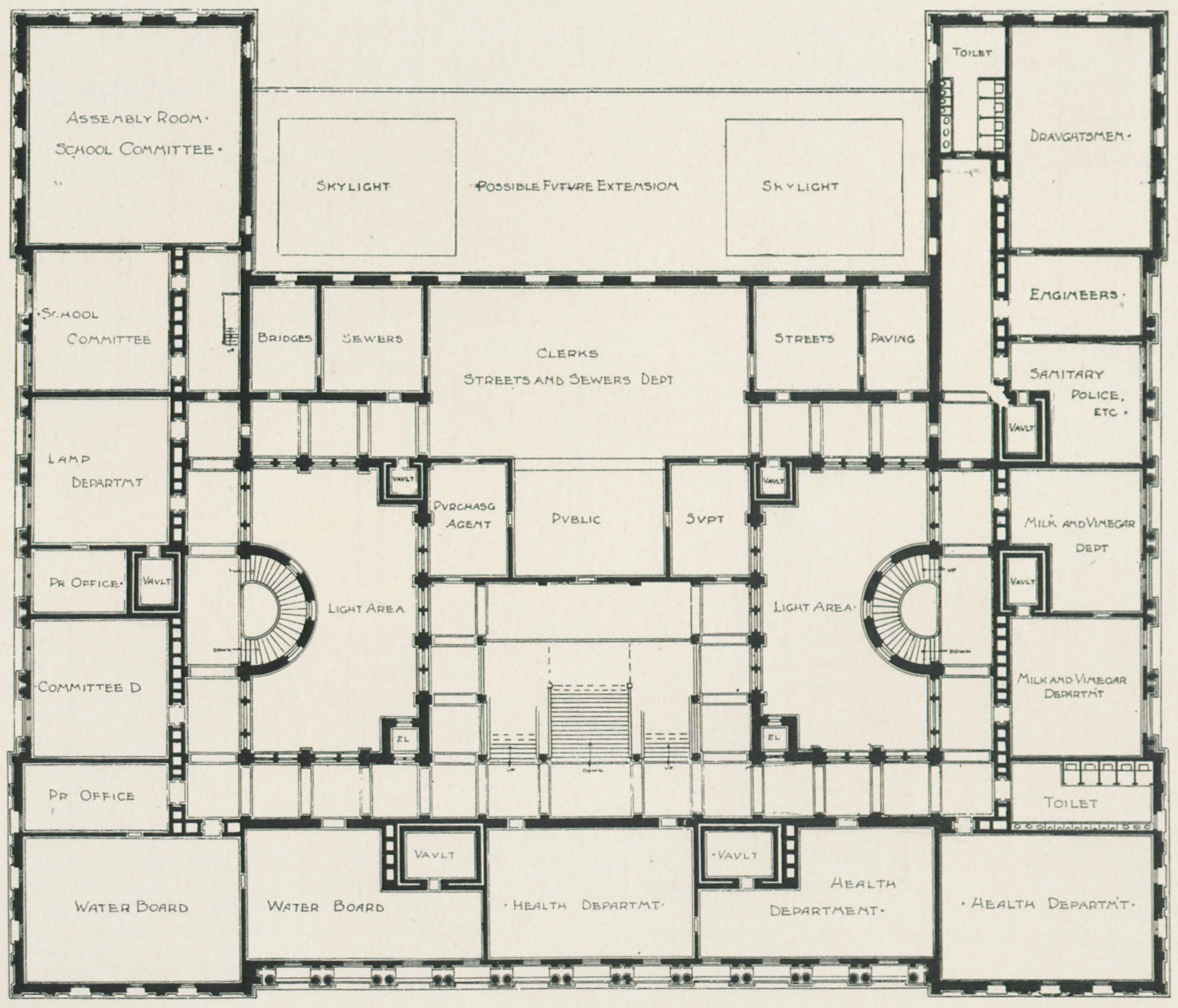
Block Plans for Location of Proposed City Hall.

The block plans presented with the report were an essential part of the suggested architectural scheme. One of these plans showed Mt. Vernon and Bowdoin streets widened, the land between the two streets being utilized as a small park. Beacon street was to be widened to about 170 feet from the proposed City Hall to the face of the buildings on the south side of the street. Another plan represented a City Hall facing the Public Garden, and provided for the joining of that park with the Charles River Embankment.



FIFTH FLOOR PLAN.

The project of a City Hall on Beacon Hill received support from most of the leading journals of Boston. The design met practical necessities, it was dignified, impressive in its refined sobriety, and worthy of the prominent site for which it was suggested. It therefore received general commendation, and the Mayor and City Council of Boston petitioned the Legislature of 1892 for the right to take land for a City Hall. This petition was necessary because in Massachusetts the special permission of the Legislature must be given to a city that

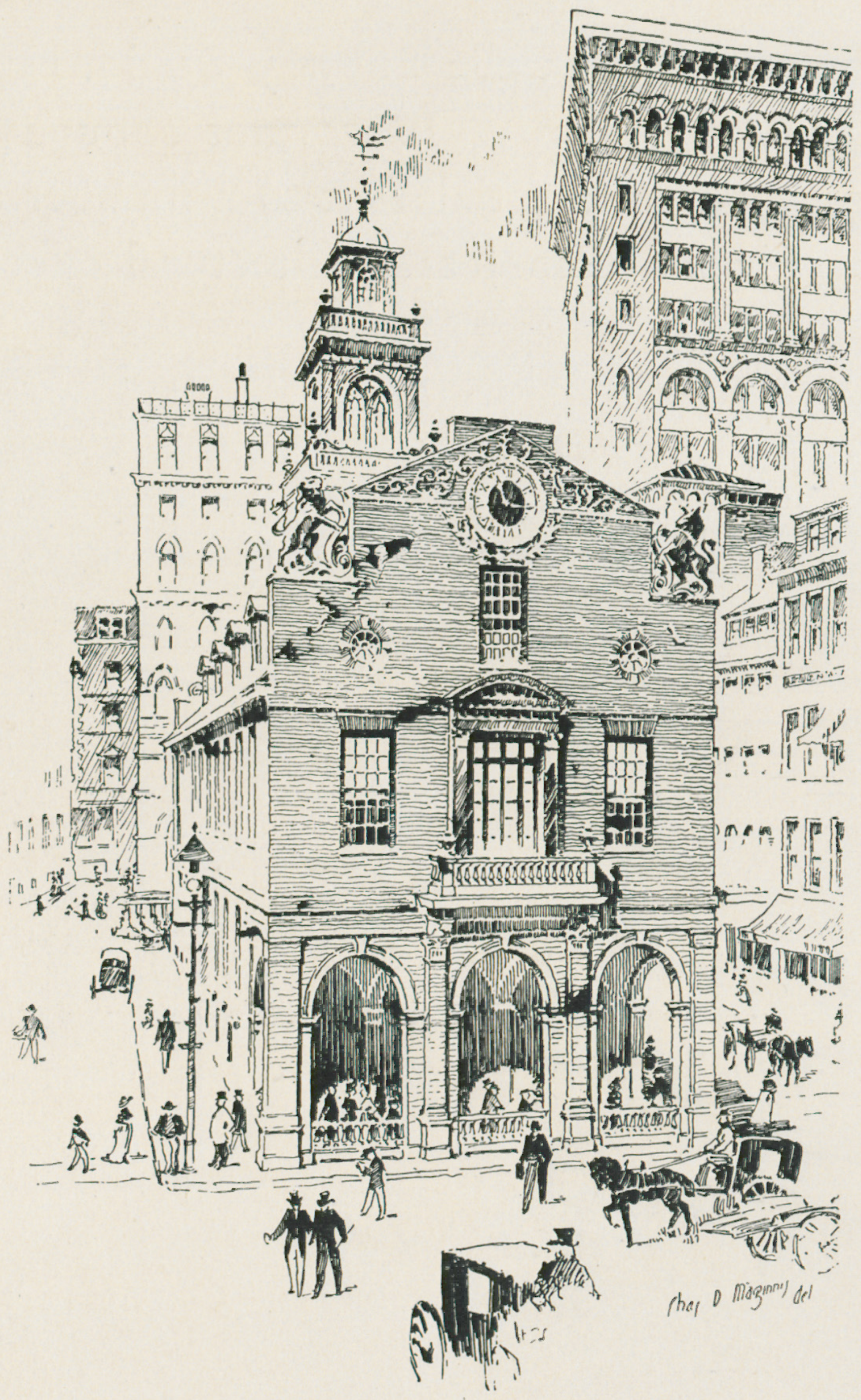


FOURTH FLOOR PLAN.

wishes to appropriate for a City Hall land in excess of an acre, and in this case considerably more than that area was needed. After much discussion the bill granting this privilege passed the Senate, but failed to pass the House. Since then no attempt has been made, and at present it appears hardly probable that a new City Hall will be erected upon Beacon Hill. This design is further illustrated by Plate XCIV.

Proposed Arcading of the Old State House.

THE City Architect was instructed to devise some method by which the Old State House, which stands at the head of State street, might be rendered less obstructive to the traffic through Devonshire street. To this end it was proposed to arcade the rear end of this historic building and thus gain a new sidewalk, about 16 feet wide, under the building itself. The old sidewalk was to be thrown into the roadway, and in this way the line of Devonshire street would be considerably straightened. This end of the building as originally constructed had been changed when a portico with stone steps was removed to make room for the present sidewalk. The City Architect suggested that on the wall inside the arcade might well be placed the statue and bas relief commemorating the Boston Massacre, which is now on the Boston Common. The statue would have had a better appearance backed by a wall, than it has as it now stands backed to a shaft. The proposed location for the statue had the further advantage of being near that of the event which it commemorated. This alteration of the Old State House was not made.



Study for Arcading of Old State House.

VII.

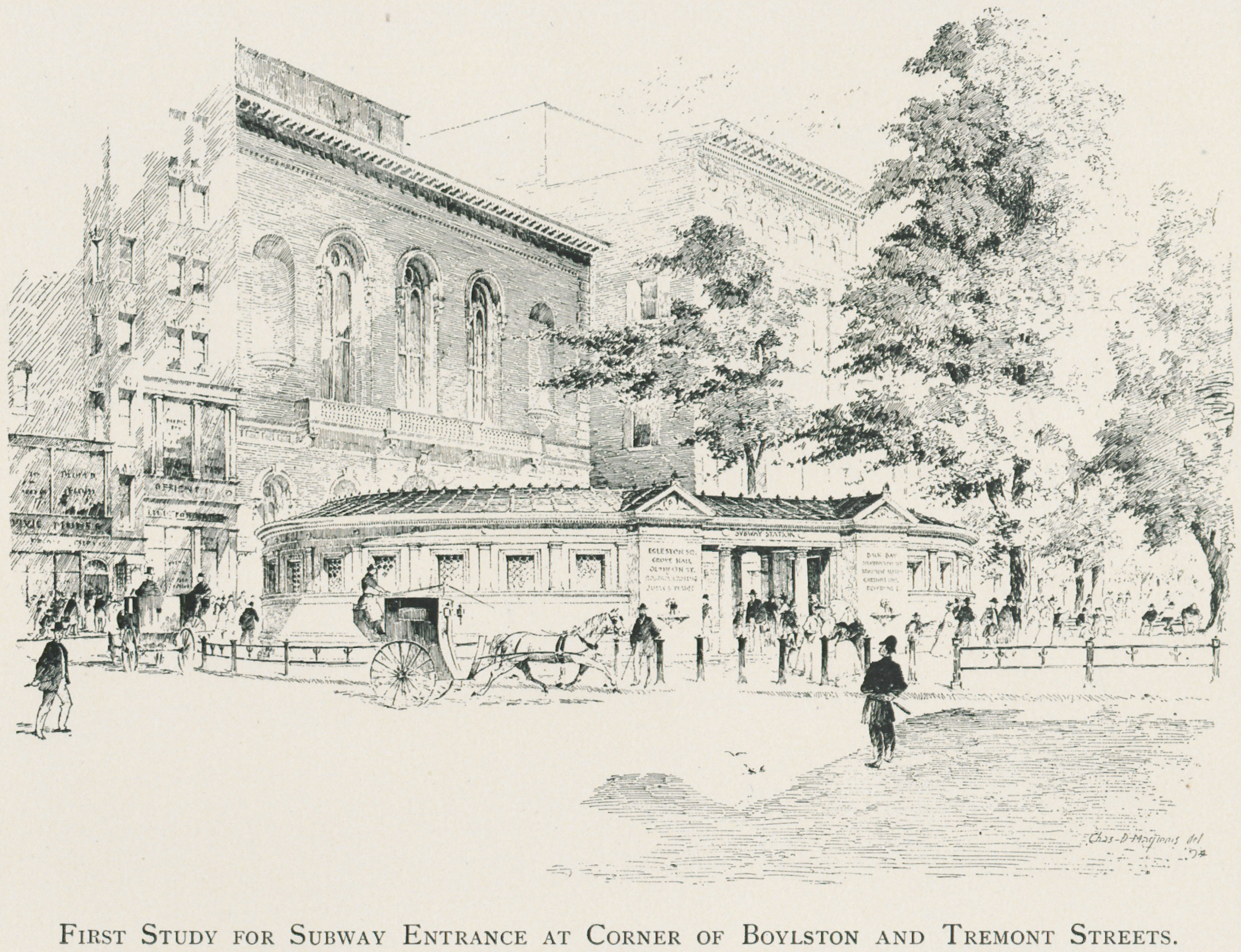
IN two cases preliminary sketches for buildings were made by Mr. Wheelwright as City Architect, but the buildings were constructed from plans made later by the architectural firm of which he is a member. These buildings are the Gate House for the Sudbury Reservoir, and the coverings on Boston Common for the stairways to the Subway Stations.

Gate House for Sudbury Reservoir.

THE GATE HOUSE for Sudbury Reservoir is of selected Fitchburg granite. The lining of the inner walls is of buff terra cotta brick. The roof is of Georgia pine, covered with copper. The doors are of iron and the sash are of white pine. The window grilles are of wrought iron. The cost was about $18,000.00. This building is illustrated by Plate XCV.

Coverings for Stairways to Subway Stations on Boston Common.

THE COVERINGS for the stairways to the Subway Stations upon Boston Common presented a peculiarly difficult problem. It was not enough that the isolated buildings should be acceptable in design; it was essential that to a number of small and comparatively inconspicuous units should be given a complete architectural effect. These units were but a



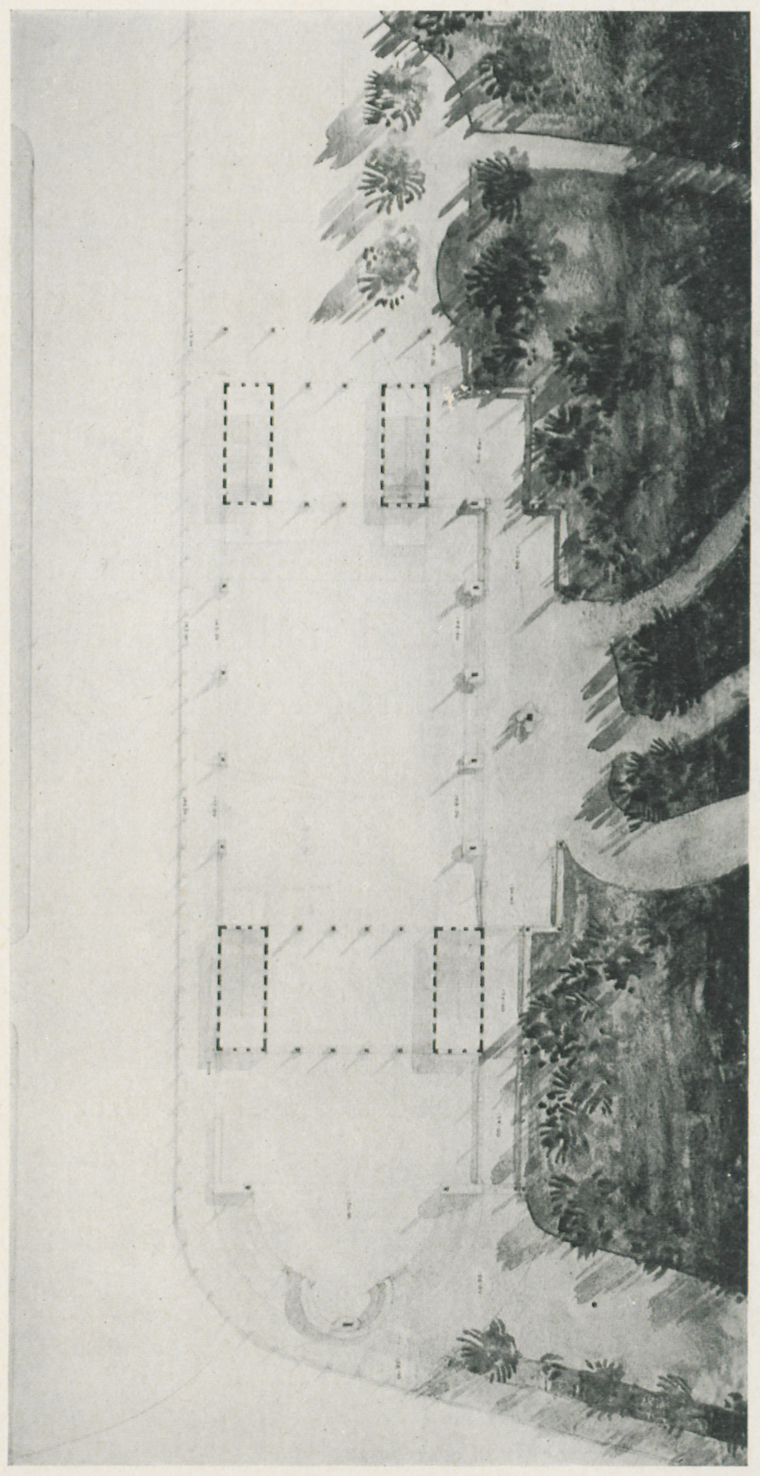
FIRST STUDY FOR SUBWAY ENTRANCE AT CORNER OF BOYLSTON AND TREMONT STREETS.

series of utilitarian buildings of the lowest organic type, mere oblong coverings for holes in the ground whose location even was determined by the engineering construction.

Original plan for Coverings.

As appears from the preliminary sketches here shown, the problem was approached in the only possible rational manner. There was a long, narrow, nearly level mall, at either end of which the coverings were to be grouped. The natural surroundings, except for the background of trees, gave no assistance. A satisfactory architectural effect had to be gained entirely by artificial means. Picturesqueness was out of the question; in the first place the units were too simple and too small, and in the second place, instead of variety, there was only deadly monotony of conditions. The architects sought therefore to gain monumental effect by formal disposition of masses, by uniting the small units by colonnades or by series of lamps or posts; by the use of balustrades or walls; and by flights of steps. The coverings at Park street chanced to be so disposed that they could be arranged in pairs; and one of the early sketches shows a colonnade used to group together each of these pairs. As it was found necessary to reduce the number of stairway risers by lowering the grade of the malls, a semicircular series of broad steps was suggested at the Park street corner, while seats, posts for lamps, and other architectural features completed the assembling of the different parts of the design at this the most important end of the mall. Here, too, on the axis between the two pairs of coverings, the Brewer Fountain was to be placed, an approach to it being given by a short flight of steps. This would have been an effective and rational location for this fountain, which in its present situation appears to have been dropped there by accident. At the corner of Tremont and Boylston streets, under conditions even less favorable, the architects strove by similar means to bring together the isolated units. In fact, every expedient which would enlarge the apparent area of architectural treatment was applied to this problem.

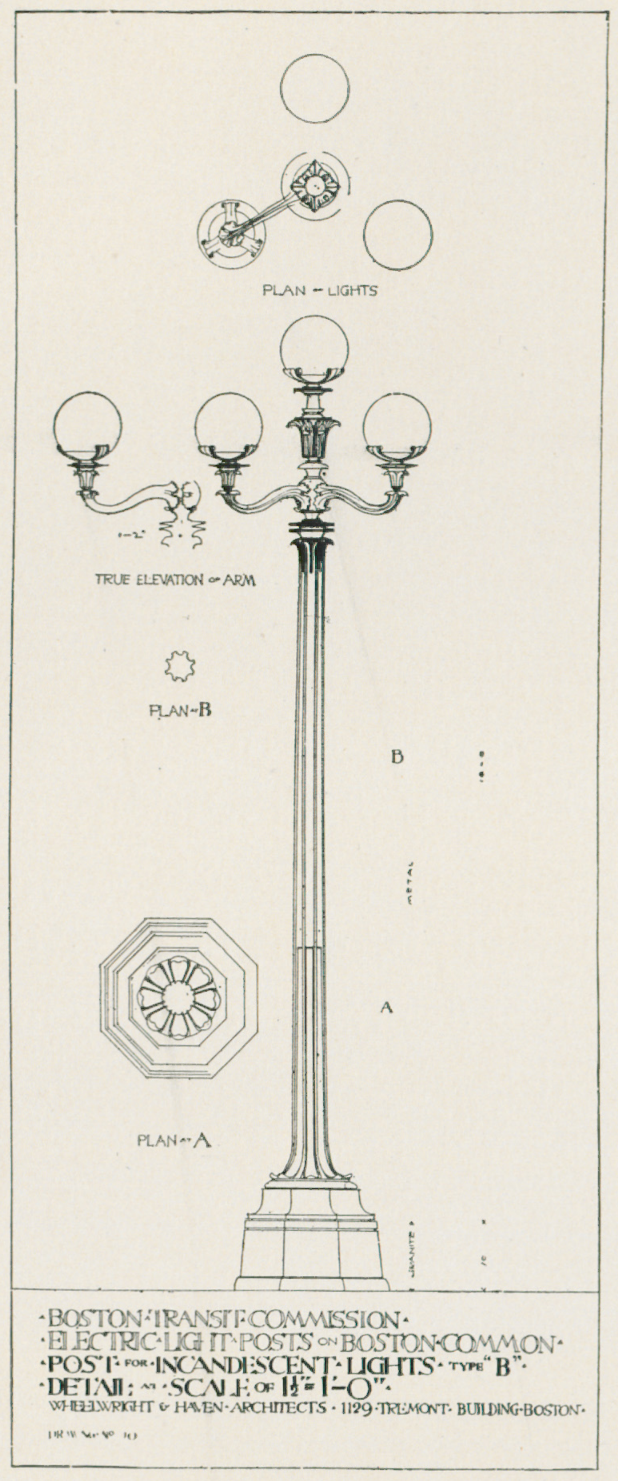
Proposed Arrangement of Subway Entrances with Brewer Fountain.

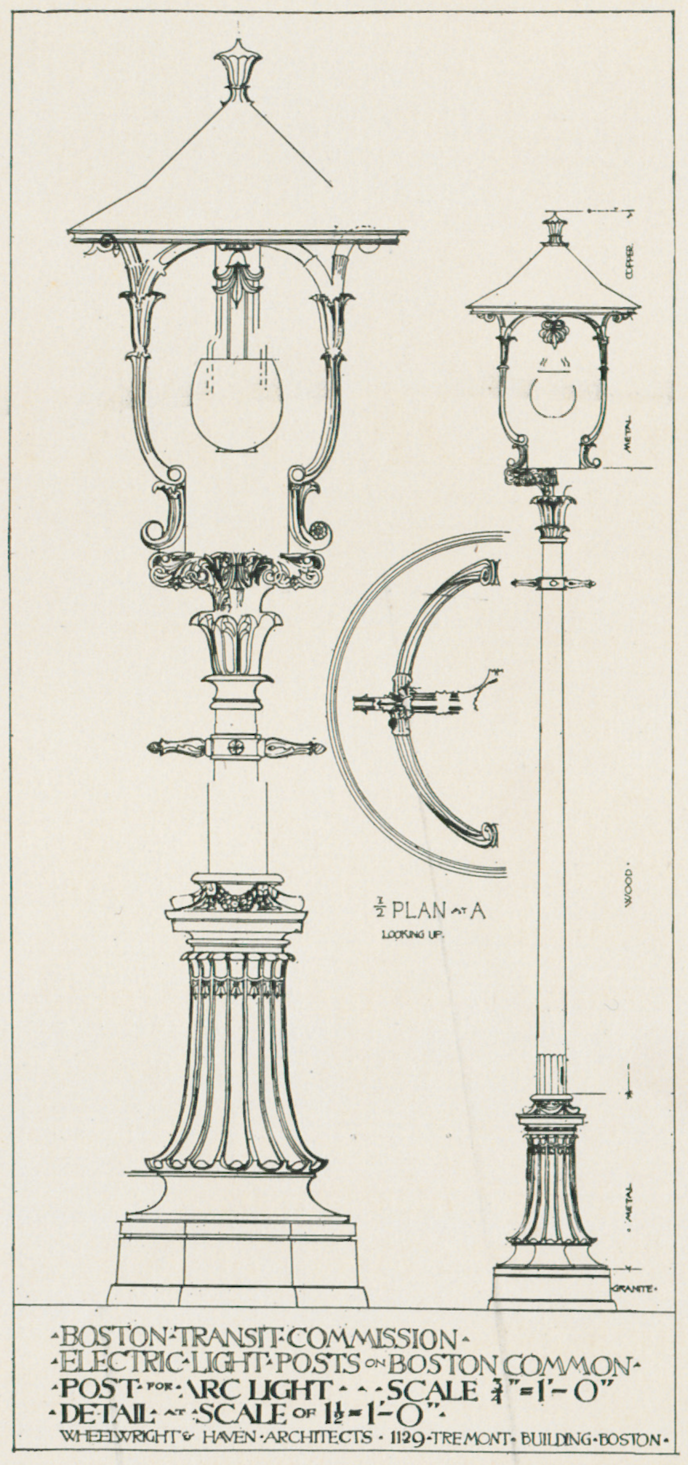


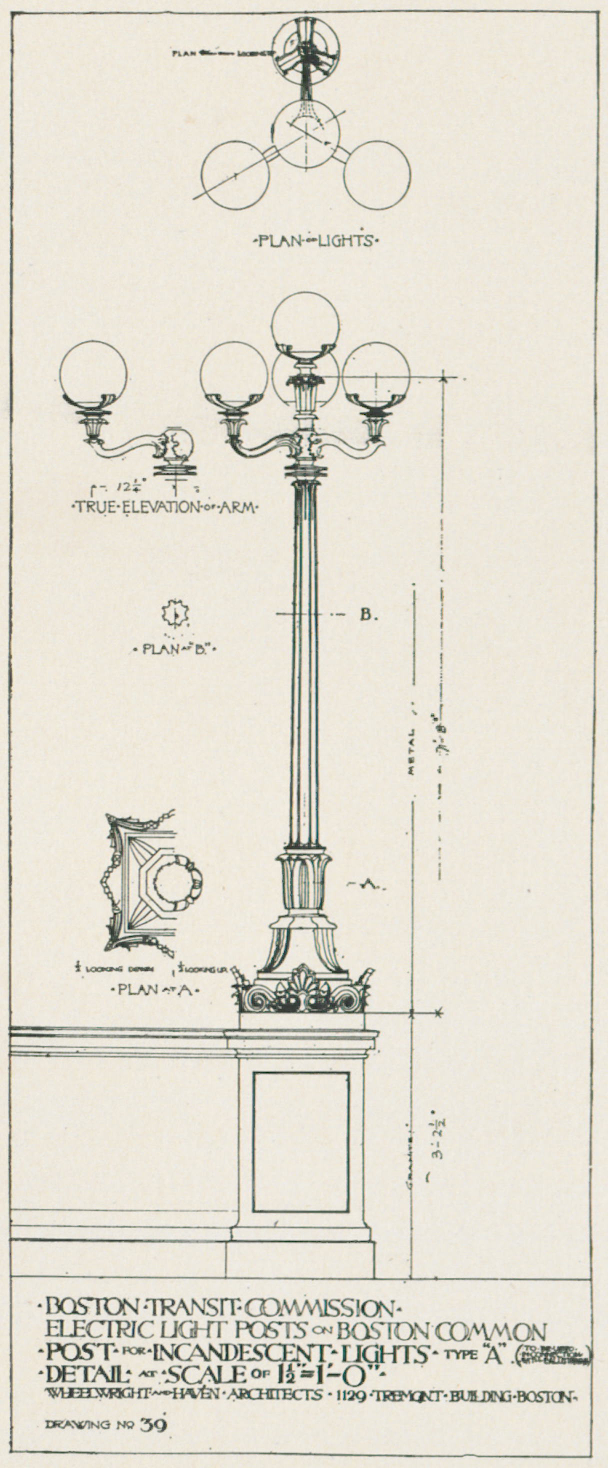
Plan of Entrances at Park Street.

Coverings as actually constructed.

The Commission, however, failed to recognize the essential characteristics of the architects' designs; none of the accessories which such conditions required were authorized, and not until the designs had been reduced to their lowest terms were they finally accepted. The buildings thus became merely a series of stone coverings for unrelated holes in the surface of the mall. Public criticism at once recognized the inadequacy of this solution of the problem. The criticism of these buildings, if analyzed, will be found to be based upon their lack of arrangement and haphazard







appearance, quite as much as upon their severity. The fragments of an excellent design have been built, and necessarily give testimony to the fact that they are merely parts of an unaccomplished whole. It might have been as well, poor as would have been their effect in such a situation, if mere pavilions of iron and glass, adaptable to any needs as far as covering capacity is concerned, had been here constructed; for the very formality and monumental character, both in form and material, of the present buildings was suggested by and related to the scheme which was discarded by the Commission. The buildings themselves are of excellent proportions, and in the details of mouldings and other features refinement and skill are shown. The responsibility for the vulgar over-sized black letters which designate the entrances and exits rests with the street railway company which has leased the Subway. The buildings are constructed of Deer Isle granite, six cut work. The interior walls are lined with white enameled brick. The interior bases and corbel courses on the steel construction are of Knoxville marble. The roof is a copper skylight. The window grilles and sign frames are of bronze. The staircases are of iron with lead treads. The cost of these eight coverings with their staircases was about $91,500.00. These coverings are further illustrated by Plates XCVI. to C.

Buildings not Described in this Work.

In addition to the work already described, the following buildings were constructed by Mr. Wheelwright when City Architect: additional cells, Deer Island; farm barn, Long Island; stable and sheds at Brighton for the Street Department; additions to pumping stations at Mystic and at Chestnut Hill; stable on Gibson street for the Water Board; North Ferry head house, East Boston; canopy for North Ferry head house, Boston; epidemic hospitals at Swett street and Galloupe's Island; alterations and additions to the Refectory at Jamaica Park; alterations and additions to Hose House No. 7; boiler and dynamo house near the Fire Department Headquarters; reconstruction of Lyceum Hall, Dorchester, for school purposes; and several other alterations and constructions equally unimportant for the purpose of description and illustration in this work.

XXXVI. Bowdoin School — School Room.
XXXVII. Bowdoin School — Detail Working Drawing.
XXXVIII. Brighton High School — Perspective Study.
XXXIX. Brighton High School.
XL. Brighton High School — Detail of Entrance.
XLI. Brighton High School — Detail of Entrance.
XLII. Brighton High School — Detail of Side.
XLIII. Brighton High School — Detail Working Drawing.
XLIV. Boston City Hospital, South Department — Gate Lodge from the Street.
XLV. Boston City Hospital, South Department — Gate Lodge from the Grounds.
XLVI. Boston City Hospital, South Department — View from Ward Building towards Nurses' Home.
XLVII. Boston City Hospital, South Department — Nurses' Home.
XLVIII. Boston City Hospital, South Department — Ward Building — Detail of Staircase Window.
XLIX. Boston City Hospital, South Department — Ward Building — Detail Working Drawing.
L. Boston City Hospital, South Department — Gate Lodge — Detail Working Drawing.
LI. Boston City Hospital — Open Surgical Ward Building.
LII. Boston City Hospital — Pathological Building — Perspective Study.
LIII. Boston City Hospital — Pathological Building.
LIV. Boston City Hospital — Pathological Building — Cloister connecting Laboratory and Chapel.
LV. Boston City Hospital — Pathological Building — Detail of Chapel.
LVI. Boston City Hospital — Pathological Building — Interior of Chapel.
LVII. Boston City Hospital — Pathological Building — Detail Working Drawing of Chapel.
LVIII. Boston City Hospital — Pathological Building — Autopsy Room.
LIX. Boston City Hospital — Ambulance Stable.
LX. Boston City Hospital — Power House.
LXI. Boston City Hospital — Power House — Detail.
LXII. Hospital and Dormitories for Women, Long Island.
LXIII. Boston Lunatic Hospital — Pierce Farm Buildings.
LXIV. Boston Lunatic Hospital — Pierce Farm — Dormitory.
LXV. Boston Lunatic Hospital — Pierce Farm — Dormitory.
LXVI. Boston Lunatic Hospital — Austin Farm — Dormitory.
LXVII. Boston Lunatic Hospital — Austin Farm — Dormitory.
LXVIII. Boston Lunatic Hospital — Austin Farm — Chapel.
LXIX. Parental School — Dormitory.
LXX. Parental School — Dormitory — Detail.
LXXI. Parental School — Dormitory — Detail of Cornice.
LXXII. Ashmont Engine House.
LXXIII. Ashmont Engine House — Detail Working Drawing.
LXXIV. Ladder House I.
LXXV. Fire Department Headquarters.
LXXVI. Fire Department Headquarters — Detail of Tower.
LXXVII. Fire Department Headquarters — Detail of First Story.
LXXVIII. Fire Department Headquarters — Alarm Apparatus Room.
LXXIX. Brighton Police Station — Detail of Entrance.
LXXX. Brighton Police Station — Detail of Side.
LXXXI. Patrol Wagon House and Court Room, Station XIII.
LXXXII. Patrol Wagon House and Court Room, Station XIII. — Detail of Side Entrance.

LIST OF PLATES.

I. Abby W. May School.
II. Blackinton School.
III. Margaret Fuller School.
IV. Margaret Fuller School — Detail of Entrance.
V. Williams School.
VI. Williams School.
VII. Williams School — Detail of Entrance.
VIII. William H. Kent School — Detail of Entrance.
IX. Mechanic Arts High School.
X. Mechanic Arts High School — Detail of Corner Pavilion.
XI. Mechanic Arts High School — Tower.
XII. Agassiz School.
XIII. Agassiz School — Detail of Entrance.
XIV. Agassiz School — Detail Working Drawing.
XV. Robert Gould Shaw School.
XVI. Robert Gould Shaw School — Detail of Entrance.
XVII. Cudworth School.
XVIII. Choate Burnham School.
XIX. Choate Burnham School — Detail of Entrance.
XX. Andrews School.
XXI. Andrews School — Detail of Side Entrance.
XXII. Christopher Gibson School — Detail of Front.
XXIII. Christopher Gibson School — Detail of Front.
XXIV. Eustis School.
XXV. Eustis School — Detail of Entrance.
XXVI. Stephen M. Weld School.
XXVII. Stephen M. Weld School — Detail of Entrance.
XXVIII. Gilbert Stuart School.
XXIX. Gilbert Stuart School — Detail of Entrance.
XXX. Gilbert Stuart School — Detail of Entrance.
XXXI. Gilbert Stuart School — Detail of Side.
XXXII. Bowdoin School — Perspective Study.
XXXIII. Bowdoin School.
XXXIV. Bowdoin School — Detail of Entrance.
XXXV. Bowdoin School — Detail of Side.

LXXXIII. Shelter, Franklin Park.
LXXXIV. Athletic House for Men, Charlesbank.
LXXXV. Skating House and Shelter, Franklin Park — Perspective Study.
LXXXVI. Shelter for the Fens — Perspective Study.
LXXXVII. Shelter for the Fens — Detail Working Drawing.
LXXXVIII. Boat House, Jamaica Park — Detail Working Drawing.
LXXXIX. Head House of Pier, Marine Park — Detail Working Drawing.
XC. Head House of Pier, Marine Park.
XCI. Head House of Pier, Marine Park.
XCII. Head House of Pier, Marine Park — Detail of Entrance.
XCIII. Head House of Pier, Marine Park — Detail showing Sgraffito Work.
XCIV. Proposed Boston City Hall — Perspective Study.
XCV. Gate House, Sudbury Reservoir — Detail Drawing.
XCVI. First Sketch for Subway Coverings for Stairway on Boston Common Mall.
XCVII. Sketch for Subway Coverings, Boston Common.
XCVIII. Birdseye view of Boston Common Mall at Park street, showing Subway Coverings.
XCIX. Subway Covering, Boston Common.
C. Subway Covering, Boston Common — Detail Working Drawing.

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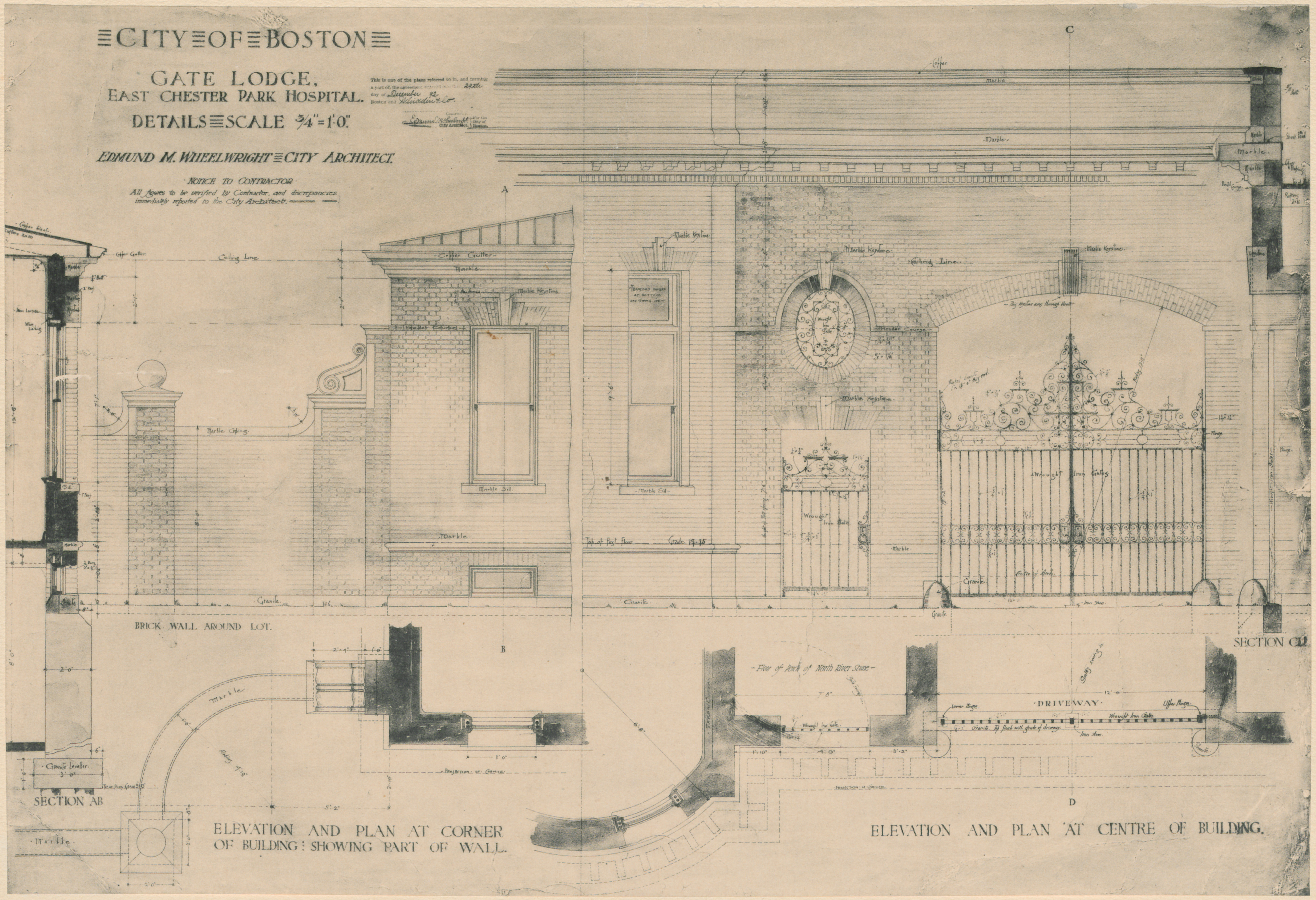

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Plate L. Boston City Hospital, South Department—Detail Working Drawing of Gate Lodge.

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Plate LI. Boston City Hospital — Open Surgical Ward Building.

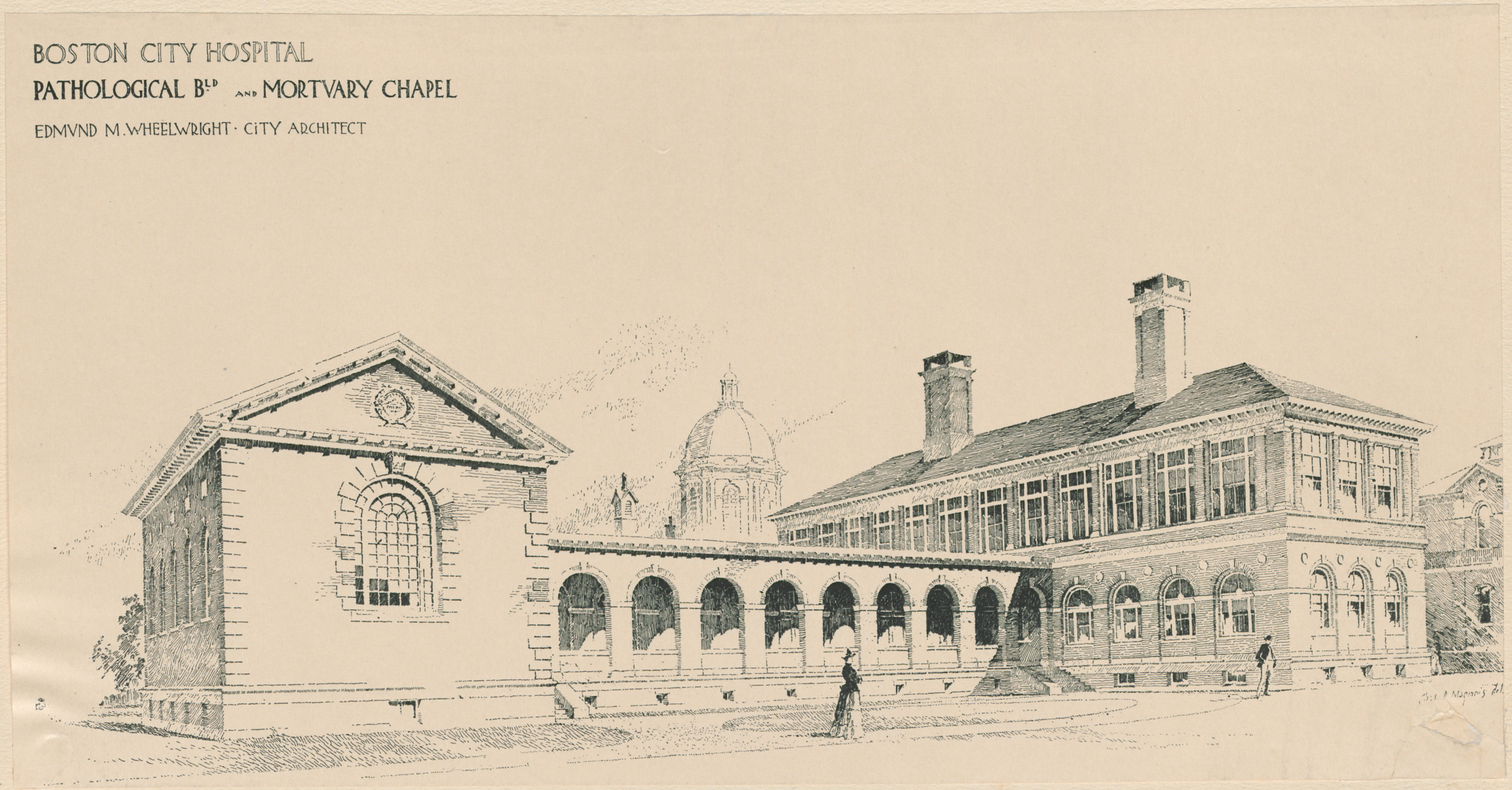

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Plate LII. Boston City Hospital — Pathological Building — Perspective Study.

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Plate LIII. Boston City Hospital—Pathological Building.

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Plate LIV. Boston City Hospital—Pathological Building—Cloister connecting Laboratory and Chapel.

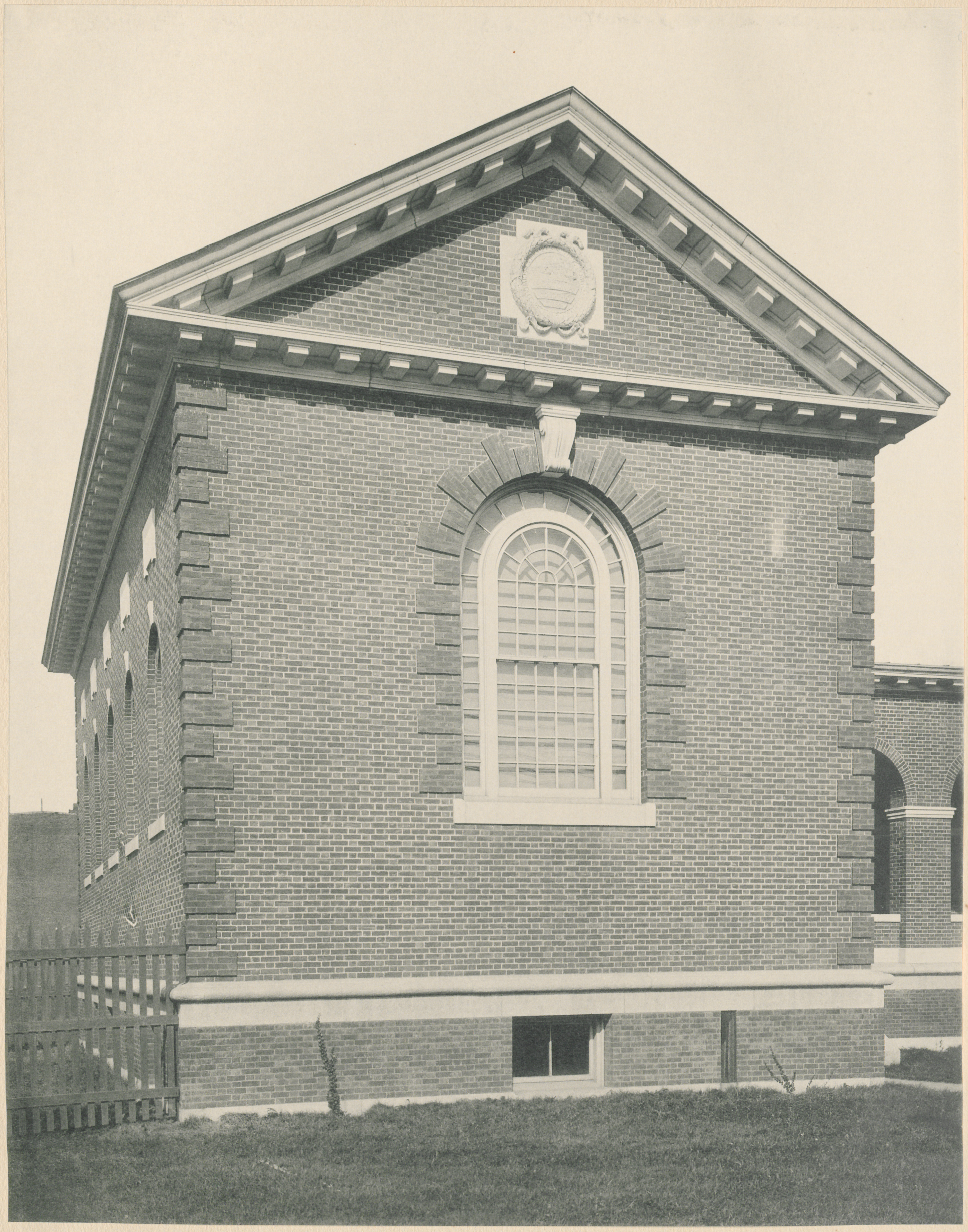

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Plate LV. Boston City Hospital — Pathological Building — Detail of Chapel.

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Plate LVI. Boston City Hospital — Pathological Building — Interior of Chapel.

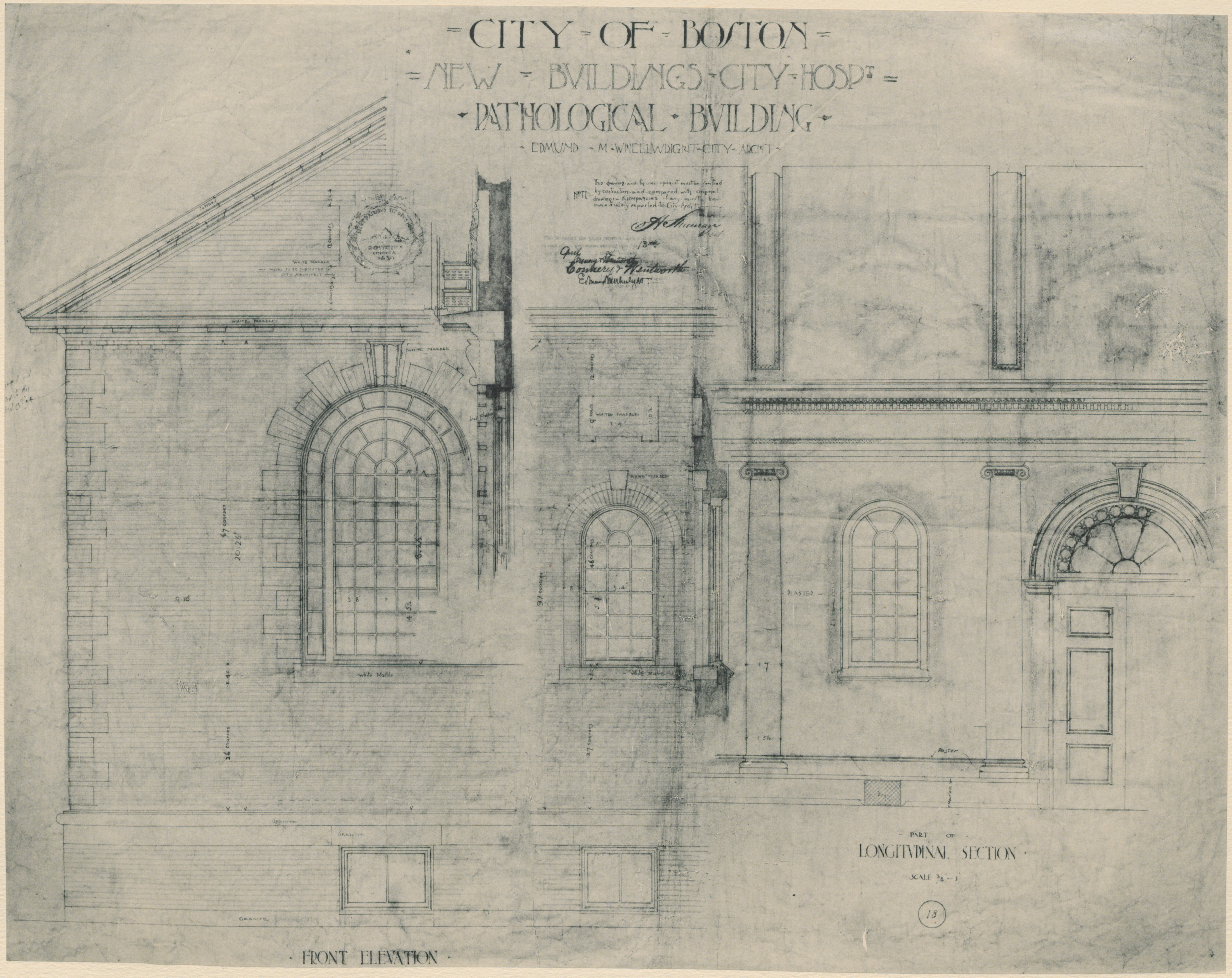

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Plate LVII. Boston City Hospital — Pathological Building — Detail Working Drawing of Chapel.

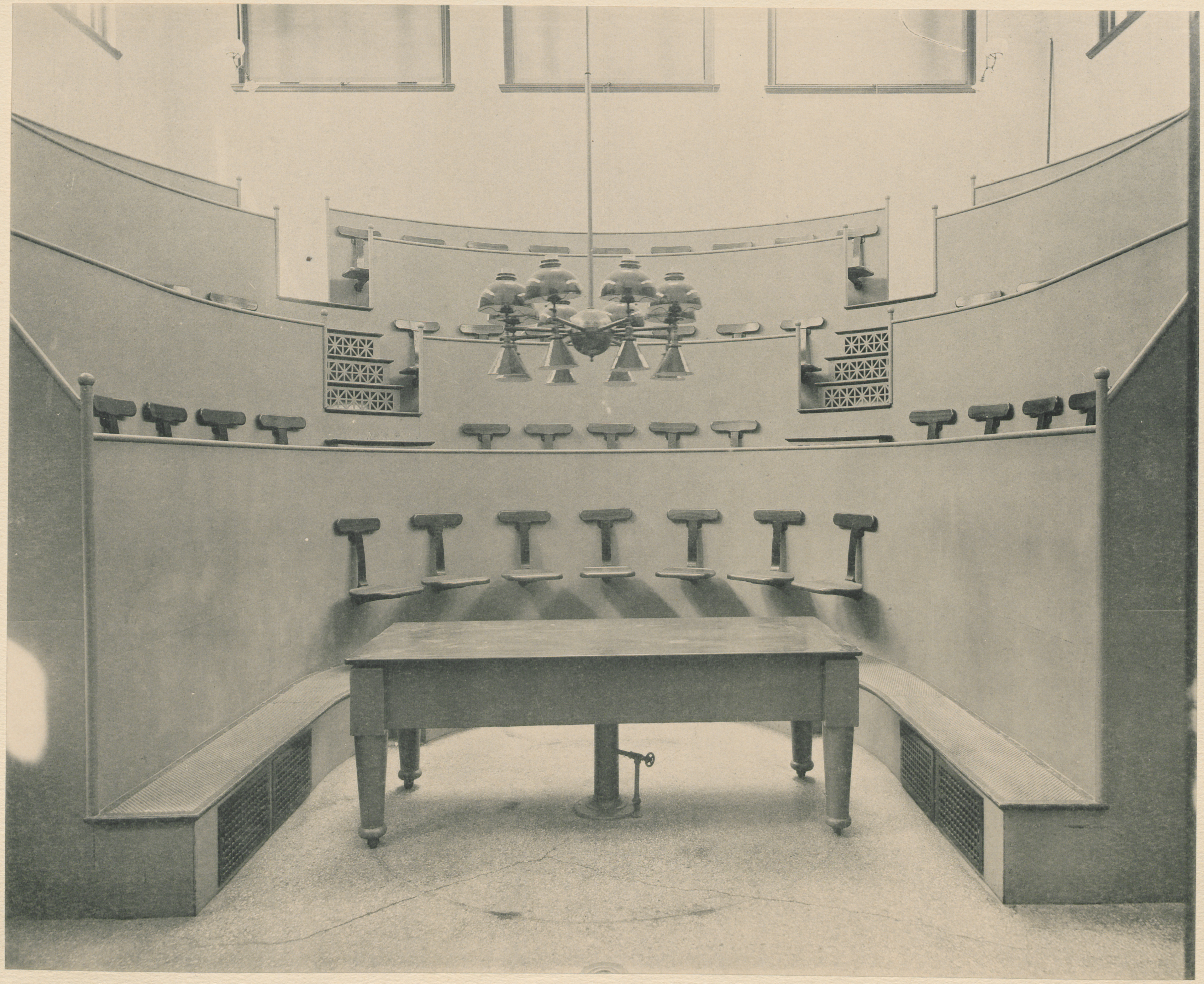

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Plate LXI. Boston City Hospital—Power House—Detail of Entrance.

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Plate LXIV. Boston Lunatic Hospital—Pierce Farm—Dormitory.

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LXXVI. Fire Department Headquarters — Detail of Tower.

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Plate LXXVII. Fire Department Headquarters—Detail of First Story.

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Plate LXXVIII. Fire Department Headquarters — Alarm Apparatus Room.

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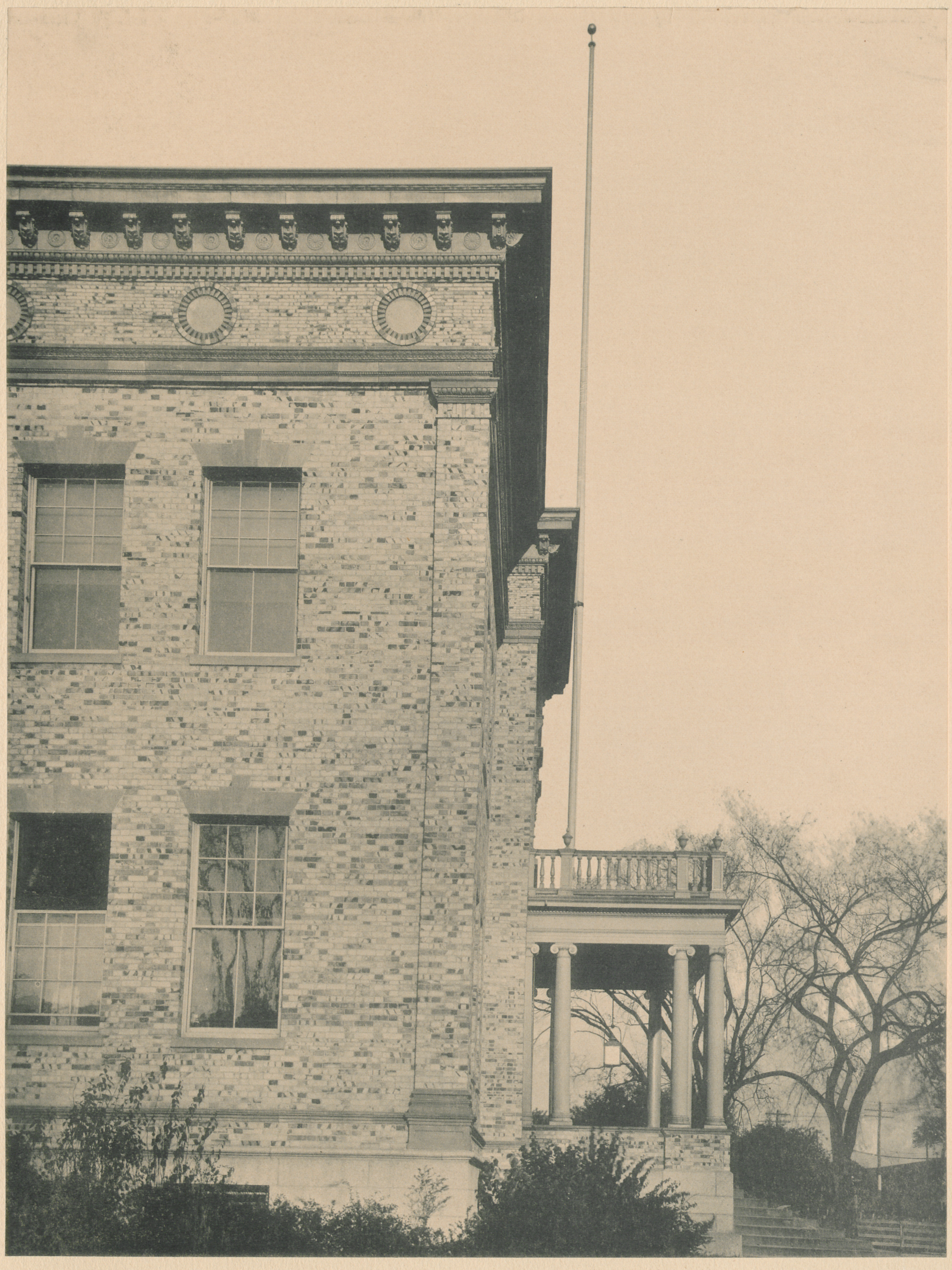
LXXIX. Brighton Police Station — Detail of Entrance.



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LXXX. *Brighton Police Station — Detail of Side.*

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LXXXII. Patrol Wagon House and Court Room, Station XIII — Detail of Side Entrance.

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Plate LXXXIII. Shelter, Franklin Park.

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Plate LXXXIV. Athletic House for Men, Charlesbank.

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Plate LXXXV. Skating House and Shelter, Franklin Park—Perspective Study.

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Plate LXXXVI. Shelter for the Fens—Perspective Study.

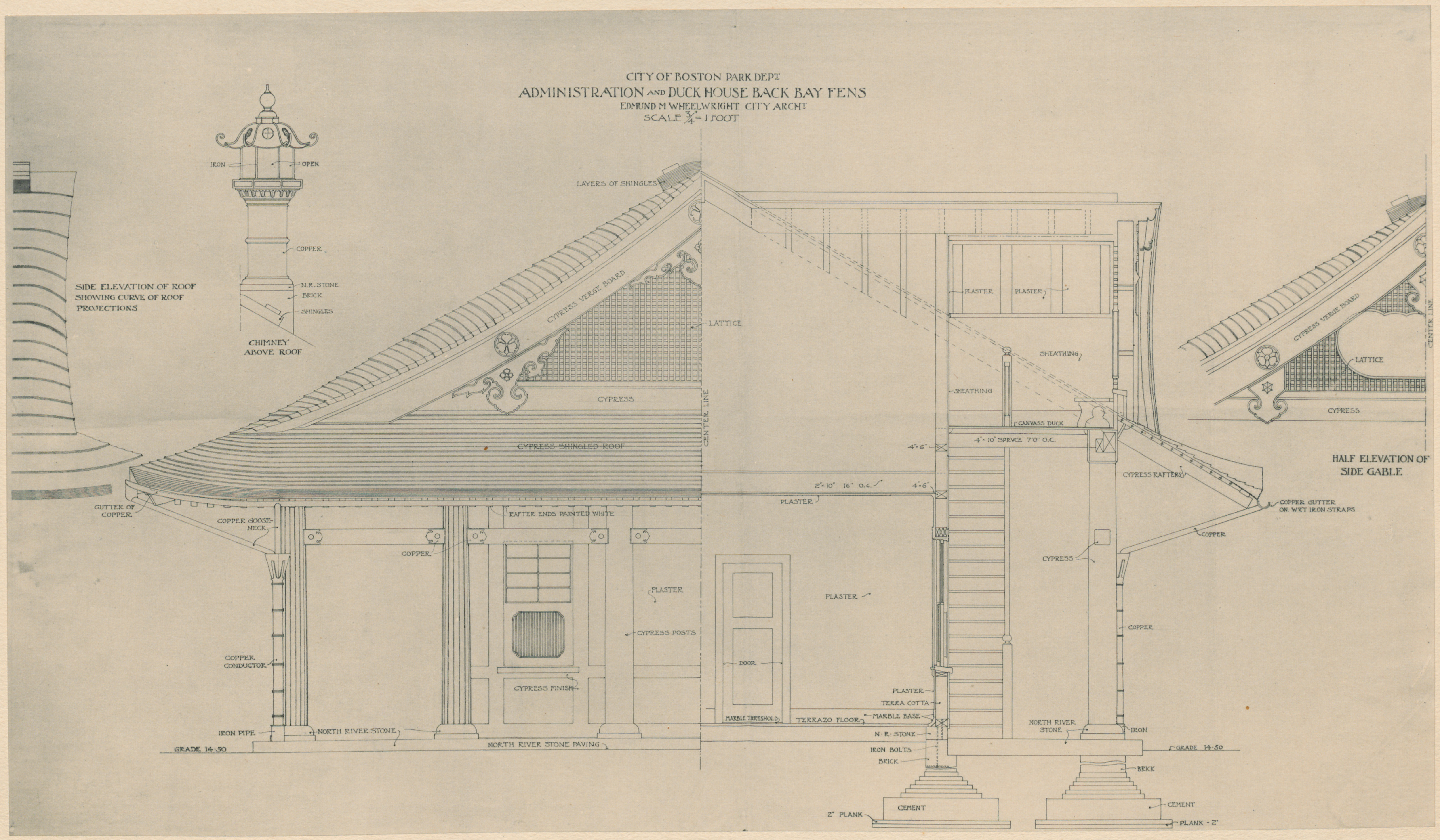

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Plate LXXXVII. Shelter for the Fens — Detail Working Drawing.

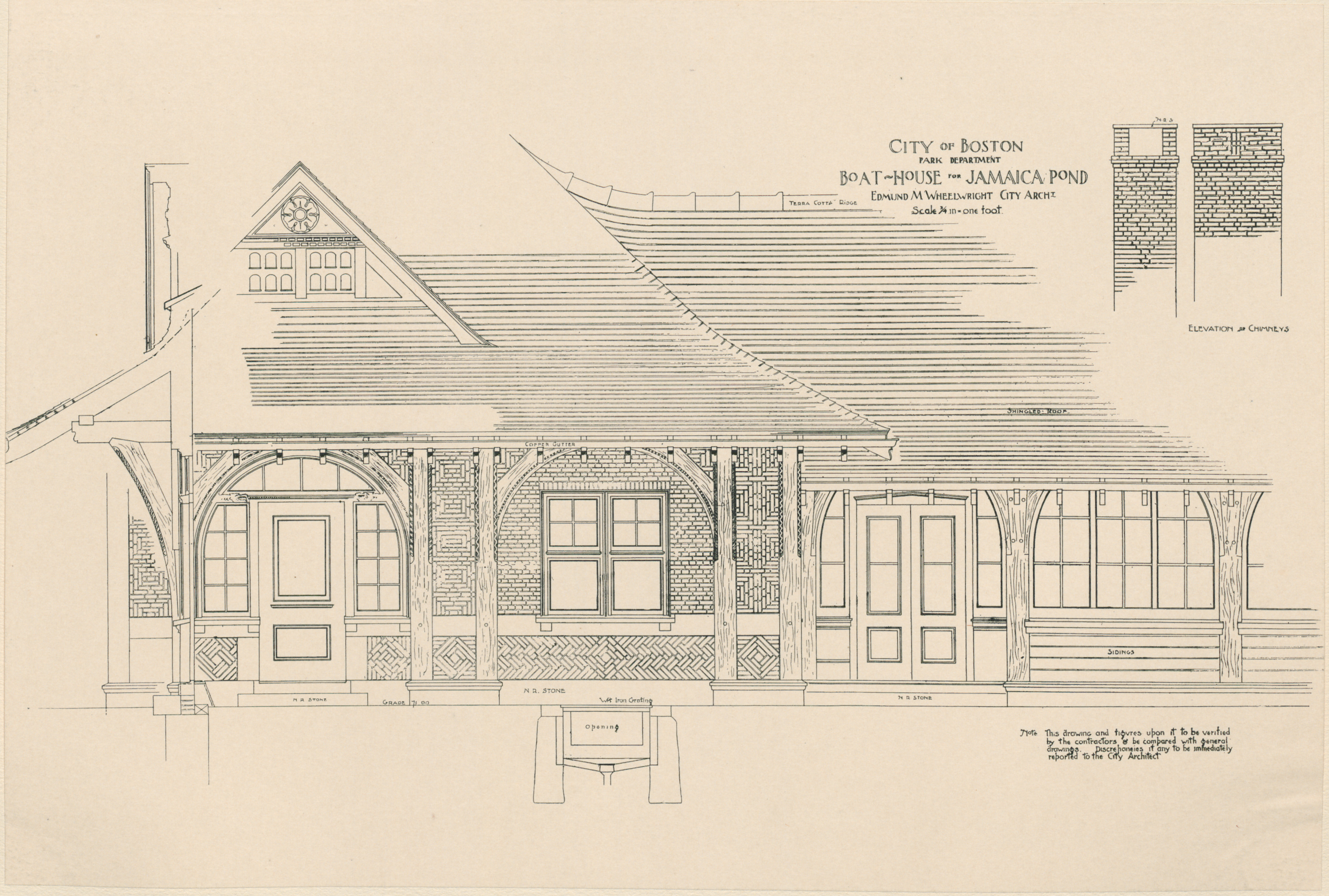

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Plate LXXXVIII. Boat House, Jamaica Park—Detail Working Drawing.

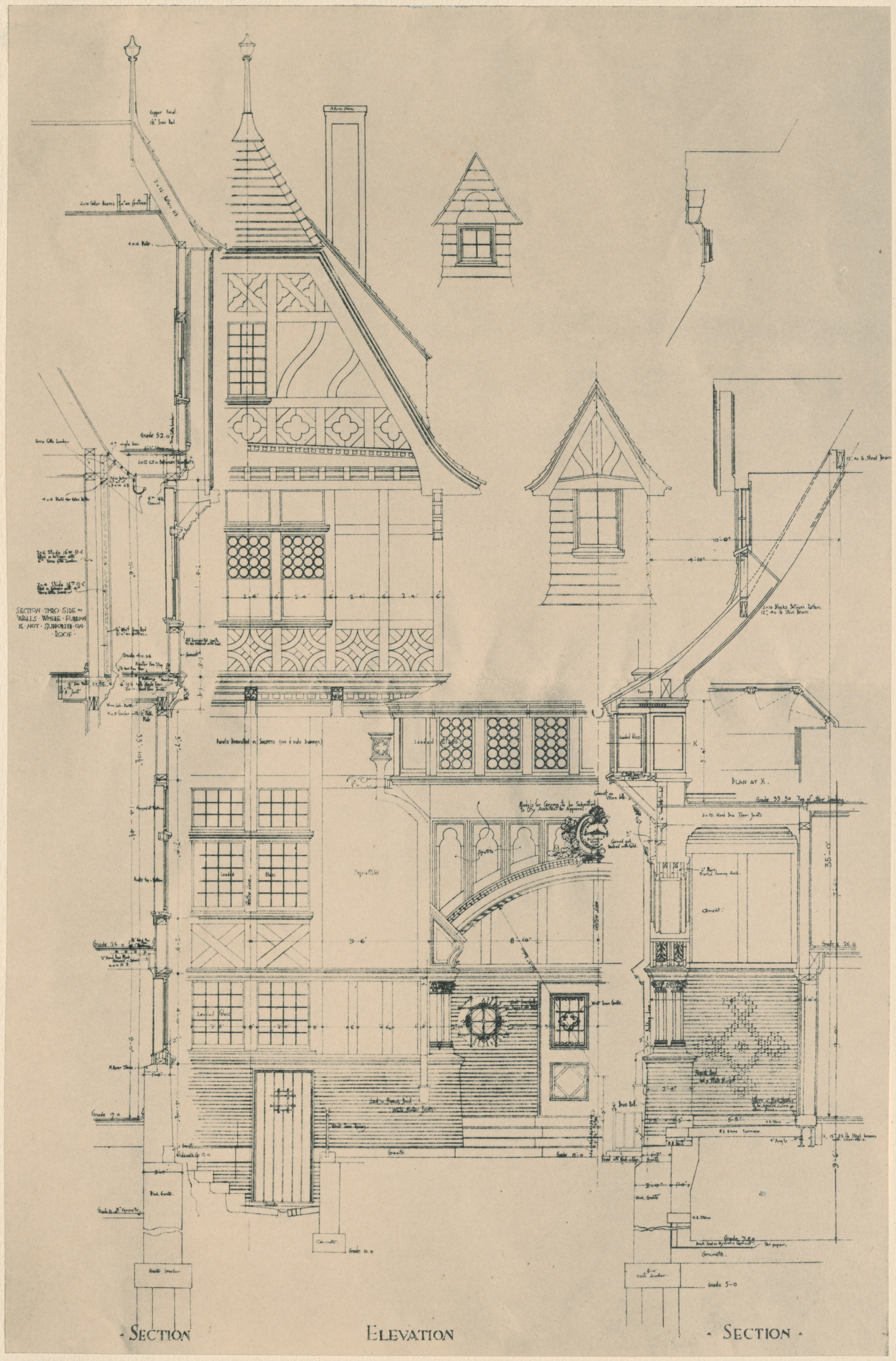

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Plate XC. Head House of Pier, Marine Park.

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Plate XCII. Head House of Pier, Marine Park — Detail of Entrance.

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Plate XCIII. Head House of Pier, Marine Park—Detail showing Sgraffito Work.

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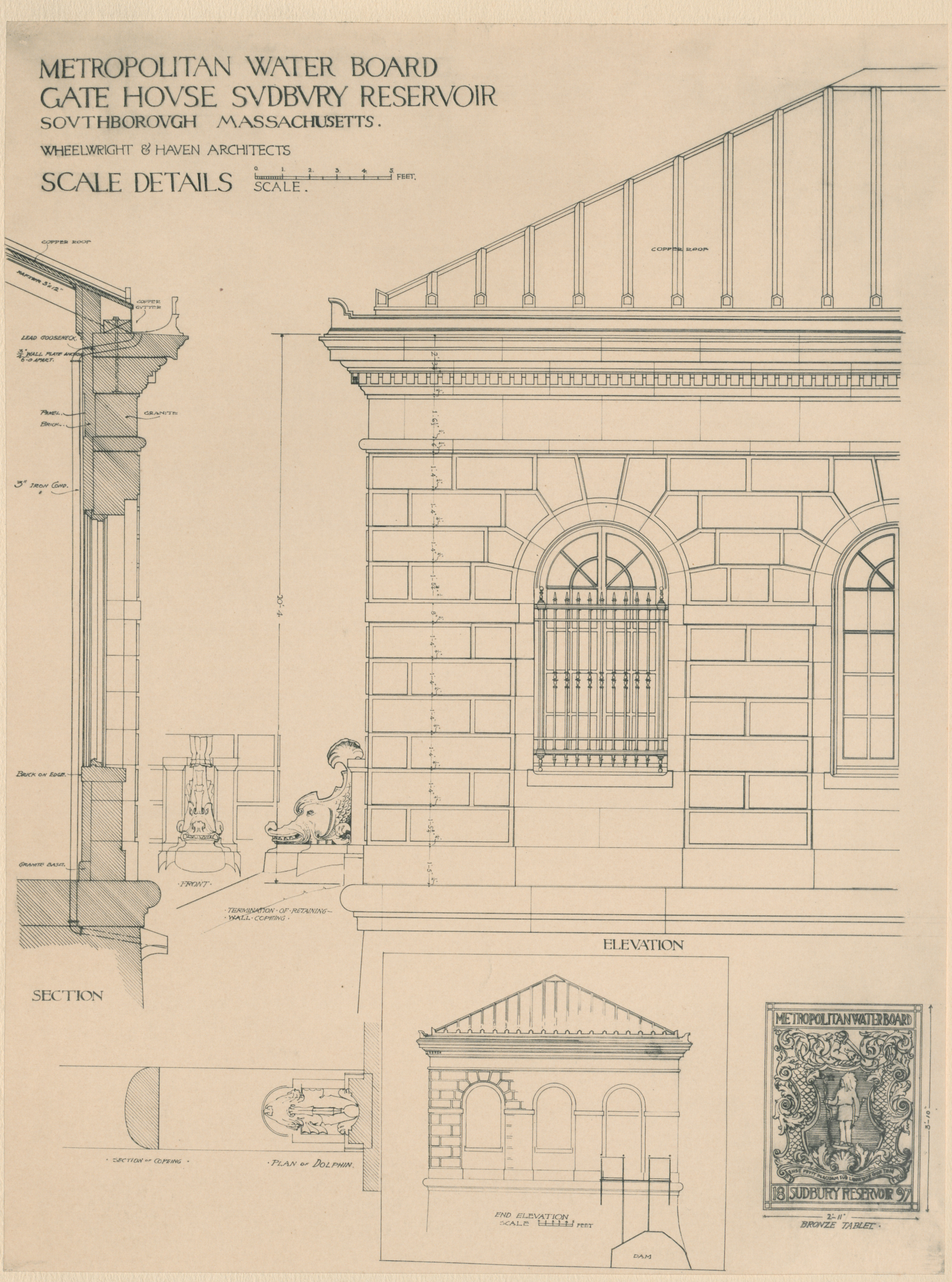
Plate XCIV. Proposed Boston City Hall — Perspective Study.



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XCV. Gate House, Sudbury Reservoir — Detail Drawing.

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Plate XCVI. First Sketch for Subway Coverings for Stairway on Boston Common Mall.

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Plate XCVII. Sketch for Subway Coverings, Boston Common.

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XCVIII. Birdseye View of Boston Common Mall at Park Street, showing Subway Coverings.

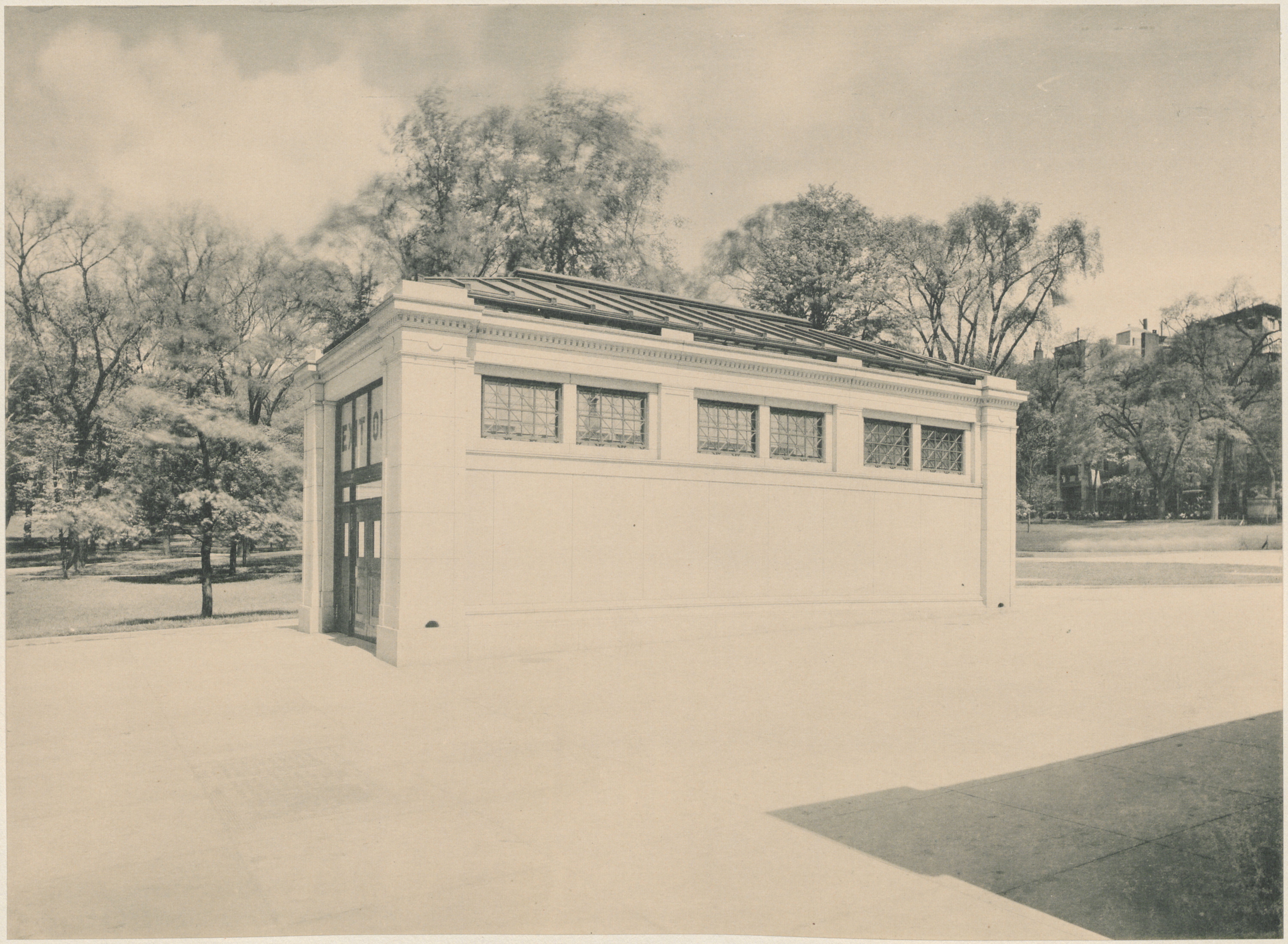

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Plate XCIX. Subway Covering, Boston Common.

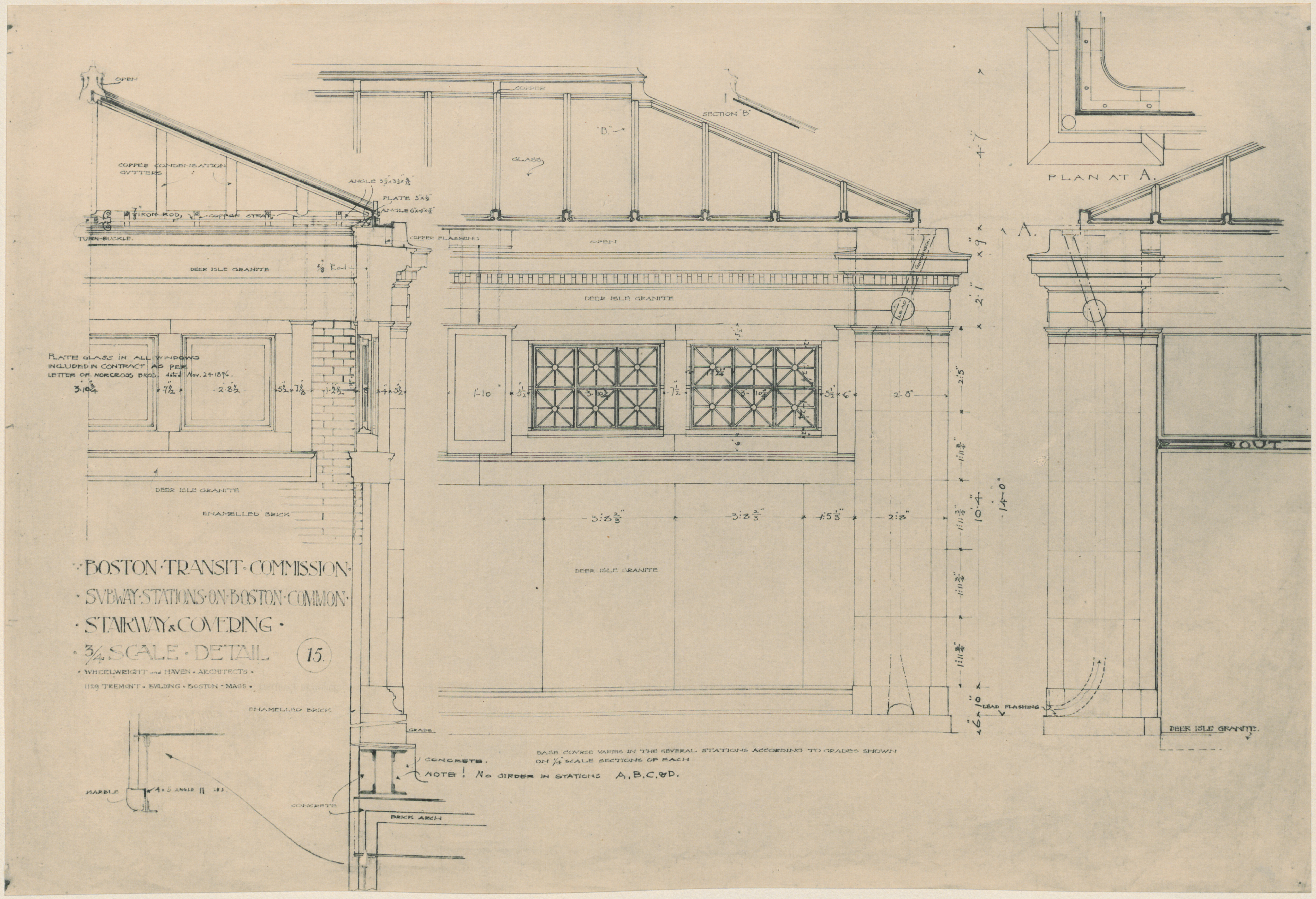

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Plate C. Subway Covering, Boston Common—Detail Working Drawing.